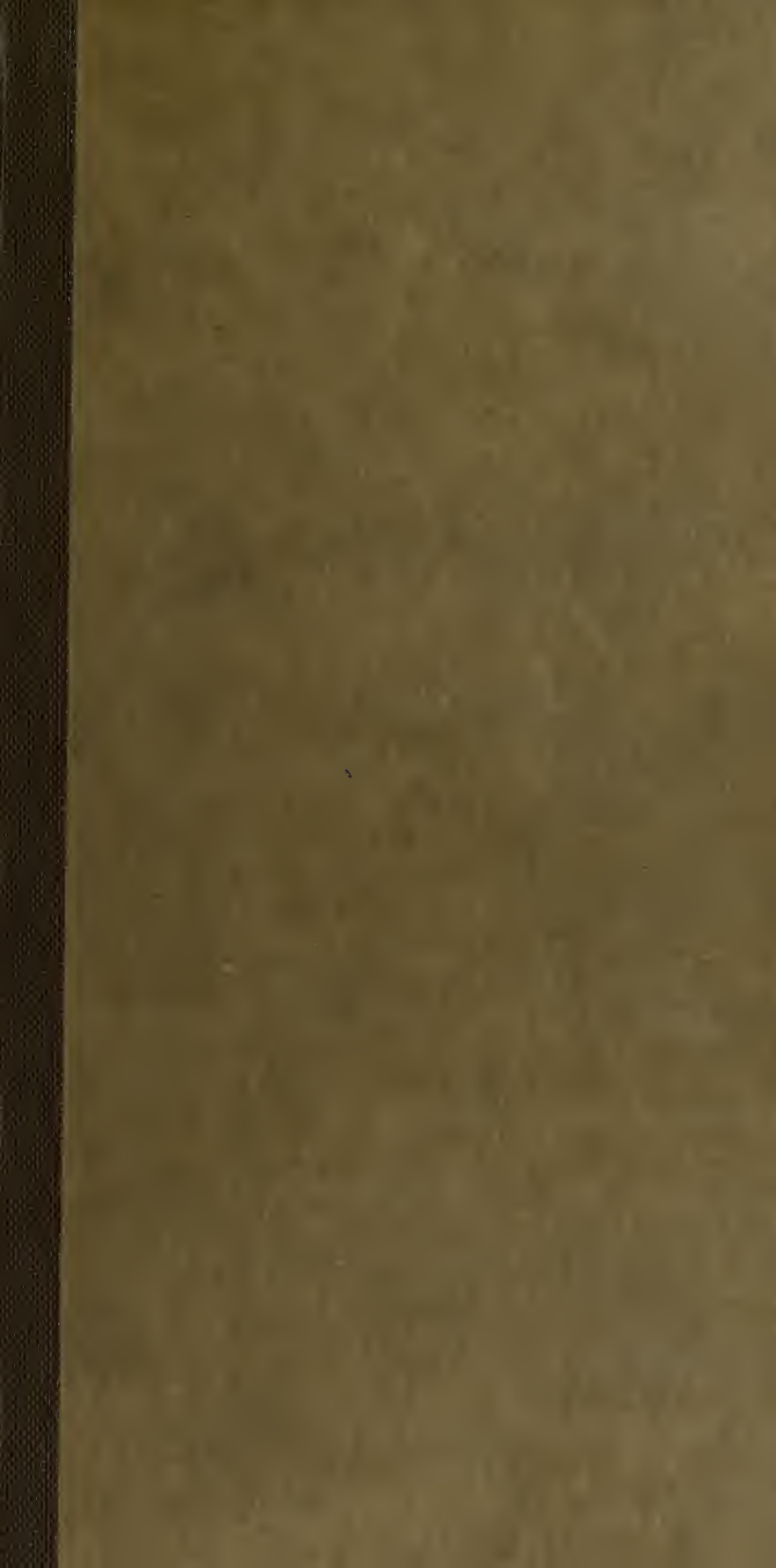




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UNITED STATES DEPARTMENT OF AGRICULTURE



FARMERS' BULLETIN



WASHINGTON, D. C.

676

JUNE 24, 1915.

Contribution from the Bureau of Plant Industry, Wm. A. Taylor, Chief.

HARD CLOVER SEED AND ITS TREATMENT IN HULLING.

By GEORGE T. HARRINGTON, *Scientific Assistant, Seed Laboratory.*

INTRODUCTION.

The seeds of many species of the clover family are frequently incapable of readily taking up the water necessary for their germination. The reason for this incapacity is that the seed coats of such seeds are completely waterproof—at least for a time.

Seeds having such impervious seed coats are known as hard-coated or simply as hard seeds.

OCCURRENCE AND SIGNIFICANCE OF HARD CLOVER SEEDS.

The occurrence of varying proportions of hard seeds in commercial lots of the different clovers has long been recognized. The question of the agricultural value of these hard clover seeds has been much discussed. Nearly all such seeds will lie in water or in wet cloths for many months without change, and frequently many of them will remain unchanged after several years in water. As soon, however, as the waterproof seed coat is broken or becomes permeable to water the seed takes up water rapidly and usually germinates, producing a strong, healthy seedling. It is of importance to the farmer who sows clover seed that germination should occur promptly instead of after a delay of indefinite duration, pending a change in the seed coat. Herein lies the greater value of clover seed which is not hard; that is to say, which is not impervious to water. Hard clover seed, especially hard sweet-clover seed, may under certain conditions be of value. If sowed early in the spring or late in the fall, so that it lies in the ground during freezing weather preceding the first growing season, much of it will germinate. Again, hard seeds remaining in the soil will, after the first winter, help to improve a clover stand which is poor in spots. For ordinary seeding purposes good clover seed which is not hard is always preferable.

NOTE.—The facts brought out in this bulletin are of special interest to farmers who grow clover for the seed, to farmers who sow clover seed, to seedsmen, and to the manufacturers and operators of clover-hulling machinery.

THE HARDNESS OF COMMERCIAL CLOVER SEED COMPARED WITH THAT GATHERED AND CLEANED BY HAND.

The percentage of hard clover seeds in commercial lots of red clover, alsike clover, and white clover usually is comparatively small. In commercial lots of sweet-clover seed the proportion varies from less than 10 per cent in some lots to more than 90 per cent in others. The writer, however, has found a very large percentage of hard seed in hand-harvested and hand-hulled lots of each of these four kinds of clover. The present bulletin reports the results of investigations to discover the reason for this difference between commercial clover seed and clover seed gathered, hulled, and cleaned by hand, and also the relation of certain other factors to the character and size of the clover-seed crop.

THE HARDNESS OF CLOVER SEED NOT A VARIETAL CHARACTERISTIC.

It was at first thought that extreme hardness of seed might be a hereditary characteristic of varieties or strains of the different clovers in contrast to others which possessed no such tendency. That this is not the case is proved by the results of trials upon the experimental plats of the Seed Laboratory during the past six years (1909 to 1914 inclusive). All of the seed harvested from these plats has been gathered in small lots and hulled by hand. Each lot of this hand-hulled seed has contained a large percentage of hard seeds. The percentage has been as great in lots grown from seed only one-twentieth of which was hard as in lots from seed nineteen-twentieths of which was hard.

THE HARDNESS OF CLOVER SEED INDEPENDENT OF SOIL, SEASONAL, AND CLIMATIC CONDITIONS.

SOIL.

Red-clover seed, alsike-clover seed, white-clover seed, and white sweet-clover seed have been grown on heavy clay soil and on light sandy soil with the same degree of hardness in the resulting crop of hand-hulled seed. Seed gathered from wild wayside plants has been very hard also.

SEASON.

Samples of well-matured clover seed of one or more of the four kinds named in the preceding paragraph have been harvested and hulled by hand each season for the last six years. Each of these samples has contained a large proportion of hard seeds. Furthermore, if the seed is equally well matured it makes no difference whether it is harvested early from the first growth of the plants or later from the second growth, the first growth being cut green.

CLIMATE.

Samples of seed grown from the same original lots near Washington, D. C., at Burlington, Vt., at Madison, Wis., at Corvallis, Oreg., at Columbus, Mo., at Wooster, Ohio, and at Yuma, Ariz., and harvested and hulled by hand, have all contained a large proportion of hard seeds.

THE HARDNESS OF RED-CLOVER SEED INDEPENDENT OF ITS COLOR AND SIZE, PROVIDED THE DEGREE OF MATURITY AND METHOD OF HANDLING ARE THE SAME.

COLOR.

In one lot of hand-hulled red-clover seed 88 out of every 100 seeds were pure yellow. In another lot 83 out of every 100 seeds were dark purple. Each of these two lots had 83 per cent of hard seeds. The average percentage of hard seeds in 12 lots of predominantly light-colored seed was 89; the average in 16 lots of predominantly dark-colored seed was 88.

SIZE.

One lot of hand-hulled red-clover seed which weighed 990 milligrams per thousand seeds and another lot which weighed 1,949 milligrams per thousand seeds had, respectively, 84 per cent and 82 per cent of hard seeds. In a large number of other weighed lots the proportion of hard seeds was wholly independent of the size of the seeds.

THE EFFECT OF HARVESTING AND HULLING OPERATIONS ON CLOVER SEED.

During September, 1914, the writer visited the Fond du Lac clover-seed region of Wisconsin and procured a large number of samples of red-clover heads taken from standing clover and from clover in the windrow, cock, mow, and stack, as well as samples of seed taken immediately after it left the hulling machine. A smaller number of samples was procured of alsike clover, white clover, and white sweet clover, both hulled and in the heads. Additional samples were obtained from farmers and from operators of hulling machines as the clover hulling advanced.

The seeds from these samples of clover heads, procured as stated in the preceding paragraph, were rubbed out from the hulls by hand. Both these lots and other lots of seed which were hulled by machine were subjected to germination tests in the Seed Laboratory.

The data obtained in testing the various samples, the results of the germination tests, and the results of physical examinations of some of the samples show the effect of the various methods of curing and storing the unhulled clover and the effect of the hulling operation upon the hardness and other characteristics of the seed.

THE EFFECT OF MACHINE HULLING UPON THE GERMINATION AND HARDNESS OF CLOVER SEED.

In making the germination tests 200 well-developed, bright-looking seeds of each lot were used. A few seeds softened but did not germinate. These were excluded from the computed results of the germination tests. In this way immature seeds, seeds injured by unfavorable conditions either before or after cutting the clover, seeds infested by the chalcis fly, and a few seeds badly broken by the hulling machine were eliminated. The result of each test shows, therefore, for each 100 viable seeds how many germinated and how many remained hard at the end of the germination test.

In a little more than half the cases the machine-hulled samples and those hulled by hand were taken from clover which was grown in the same fields.

Table I shows the average number of hard seeds per hundred seed in the hand-hulled and in the machine-hulled samples of each kind and the number of samples from the germination tests of which each average is derived.

TABLE I.—Average number of hard seeds per hundred in hand-hulled and machine-hulled lots of clover seed.

Kind of seed and number of samples.	Manner of hulling.	Average number of hard seeds per 100.	Kind of seed and number of samples.	Manner of hulling.	Average number of hard seeds per 100.
Red clover:			White clover:		
299 samples.....	By hand.....	92	9 samples.....	By hand.....	9
203 samples.....	By machine...	17	5 samples.....	By machine...	3
Alsike clover:			White sweet clover:		
21 samples.....	By hand.....	90	6 samples.....	By hand.....	9
36 samples.....	By machine...	18	1 sample.....	By machine...	2

Of each 100 hand-hulled seeds of each kind 90 or more were hard. This indicates that in the natural condition nine-tenths or more of the fresh, well-matured seeds of these kinds of clover are hard-coated.

Only 17 of each 100 machine-hulled red-clover seeds, 18 of each 100 machine-hulled alsike-clover seeds, 34 of each 100 machine-hulled white-clover seeds, and 20 of each 100 machine-hulled white sweet clover seeds were hard. Evidently a great decrease in the proportion of hard seeds is caused by hulling them in a clover huller. In other words, of every 100 pounds of clover seed about 90 pounds go into the huller as hard-coated seeds of uncertain value, and of these 90 pounds 60 or 70 pounds leave the huller as valuable seeds capable of prompt germination and vigorous growth.

THE HULLING CYLINDER AND ITS EFFECT ON THE HARDNESS OF CLOVER SEED.

After the clover heads are removed from the straw by the thrashing cylinder of the hulling machine they are passed over another large cylinder, where the seeds are hulled. This hulling cylinder is completely covered with a coarse steel rasp and revolves within a concave which is covered with the same material. The concave is usually set so that there is just room for the seeds to pass between it and the cylinder. The severe rubbing, with the pressing which the seeds undergo in passing between the hulling cylinder and the concave, not only removes the hulls but so alters most of the seed coats that they become capable of admitting water. Nearly all the seeds show no visible indication of this change, but frequently a few seeds out of every hundred are noticeably broken. Some of these broken seeds are not injured except in their power to retain their vitality for a long period of time. Others are broken in such a manner as to make them valueless.

THE COMPARATIVE HARDNESS OF RED-CLOVER AND ALSIKE-CLOVER SEED HULLED BY DIFFERENT MACHINES.

Samples of hulled clover seed were received during the clover-hulling season from six different operators of clover hullers.

The samples sent by each operator were hulled from clover grown on a number of somewhat widely separated farms. Comparative examinations of these samples show considerable difference in the condition of the seeds hulled by the various machines.

Table II shows the average number of hard seeds per hundred in the samples of machine-hulled red clover and alsike clover received from each huller operator.

TABLE II.—Average number of hard seeds per hundred in samples of red-clover and alsike-clover seed hulled by different machines.

Machine.	Red clover.		Alsike clover.		Machine.	Red clover.		Alsike clover.	
	Number of samples.	Average number of hard seeds per 100.	Number of samples.	Average number of hard seeds per 100.		Number of samples.	Average number of hard seeds per 100.	Number of samples.	Average number of hard seeds per 100.
No. 1.....	38	10	5	10	No. 4.....	38	14	2	20
No. 2.....	17	11			No. 5.....	16	22	8	20
No. 3.....	25	13	3	10	No. 6.....	28	36	1	37

In samples both of red clover and of alsike clover hulled by machine No. 1 an average of 10 seeds per 100 were hard. In samples hulled by machine No. 6 an average of 36 red-clover seeds per 100 and 37 alsike-clover seeds per 100 were hard. The samples hulled by the other machines were intermediate in their proportion of hard seeds between the samples hulled by these two machines.

CLOVER HULLERS AS SCRATCHING MACHINES.

A number of machines have been devised at different times for the purpose of scratching or abrading hard seeds so that they will germinate readily. The possible effectiveness of the clover huller in bringing about this result has never been seriously considered. The results of this investigation as given in the preceding pages show that the clover huller in practice alters a large proportion of the hard seeds so that they will germinate promptly. In fact, the proportion of hard seeds in a sample of clover seed seems to express inversely the effectiveness of the huller as a scratching machine at the time when the sample under consideration was hulled. It is a question of great interest whether the construction or operation of the types of hulling machines now in use could be so modified as to leave "hard" none of the seeds which they hull.

Of the hulling machines mentioned in Table II, No. 6 was of one make and the other five of another make, differing somewhat in detail, though of the same general type. The differences in the proportion of hard seeds in samples hulled by the various machines were practically constant through the hulling season. Possibly differences in

the construction of the two kinds of machines cause the higher proportion of hard seeds in samples hulled by machine No. 6. On the other hand, the differences between the samples hulled by the other five machines, which were all of one kind, indicate that the method of operating the huller influences the proportion of hard seeds in the hulled product.

SEEDS BROKEN OR MARKED IN THE HULLING MACHINE.

As previously stated, a few seeds were broken by the hulling machine. Twenty-five bright, well-matured seeds of each of a number of samples of machine-hulled red-clover seed, 50 seeds of one sample of machine-hulled alsike clover, and 50 seeds of one sample of machine-hulled white clover were examined for the presence of such seeds. All seeds with breaks in the seed coats sufficient to be seen with a binocular magnification of 28 diameters were removed. The remaining seeds and a like number of seeds from the corresponding hand-hulled samples were then submitted to four different seed-testing experts, each of whom was totally unable, even with the help of a binocular microscope, to determine by the appearance of the seeds which samples were hulled by hand and which by machine. Since comparatively few seeds in the machine-hulled samples were broken and the remainder were nearly all capable of germination, it follows that the effect of the hulling machine on nearly all of the seeds was produced without leaving any visible evidence in their appearance.

THE NUMBER OF SEEDS BROKEN BY DIFFERENT MACHINES AND THE CHARACTER OF THE BREAKS.

Ten samples of red clover hulled by machine No. 1 and 10 samples of red clover hulled by machine No. 6 were selected for comparison. Fifty bright, well-matured seeds of each sample were examined for the presence of broken seeds or broken seed coats, using binocular lenses which magnified 65 diameters. Breaks were found in an average of about 1 seed in 50 in the samples hulled by machine No. 6, and in an average of about 1 seed in 6 in the samples hulled by machine No. 1. All of the breaks in the seeds hulled by machine No. 6 and a part of the breaks in the seeds hulled by machine No. 1 were minute cracks in the seed coats. However, a few of the seeds hulled by machine No. 1 were so broken as to destroy the embryo; in still others large pieces of the seed coat were broken away, exposing a part of the embryo. This breaking of the seeds should be avoided as far as possible. The problem of the adjustment and operation of the huller seems, then, aside from the mere hulling and cleaning of the seeds, to be a matter of the maximum reduction of the hardness of the seeds with a minimum amount of breaking of the seeds.

THE EFFECT OF ROTTING THE CLOVER IN FIELD OR STACK UPON THE QUALITY AND YIELD OF CLOVER SEED.

Many farmers allow their clover to rot for several weeks after cutting before they stack it or draw it to the barn.

Sometimes red clover cut early is allowed to lie in the swaths or windrows for two months, or even longer, exposed to all kinds of

weather conditions. Frequently, also, clover stacks, if poorly constructed or unprotected, become wet and musty. Sometimes in wet portions of the stack the clover straw will even become very black and largely decomposed before the seed is hulled. The effect of such exposure in field or stack is to cause the swelling and sometimes the germination of seeds which are not protected by hard seed coats.

Even if they do not germinate, seeds which have been thoroughly swollen for some time and subsequently dried are of no value. They are brown, frequently wrinkled, with a lusterless appearance and rough texture of the seed coat, and they possess very low vitality, if they are not actually dead. If the seeds are not thoroughly dry in the heads when cut and the cut clover is rained upon before it has had time to dry, a great many seeds may be destroyed in this manner. The damage may become still greater if portions of a stack heat and become very warm as well as wet.

In a locality where frequent rains occur during the clover-ripening season some seeds will germinate and others will become brown and dead even before the clover is cut. The proportion thus affected before the clover is cut is small.

The proportion of dead or germinated seeds in the hulled product increases according to the exposure of the clover previous to hulling. For example, (1) 169 small samples of red clover were gathered in the heads, hulled by hand, and examined for the presence of germinated seeds. One sample in every 15 gathered from standing clover, 1 sample in every 7 gathered from cut clover which showed no evidence of unusual exposure, 2 samples in every 5 from the dry outsides of stacks and from mows in the barn, 3 samples in every 5 from the very wet and sometimes rotten undersides of cocks or windrows, where they had lain for weeks, and 3 samples in every 5 from wet, decayed portions of unprotected stacks contained germinated seeds. (2) A number of samples were carefully examined for the proportion of dead and germinated seeds. The average proportion of dead or germinated seeds in 17 samples of red-clover seed gathered from standing clover was 1 seed in every 25. The average proportion in 13 samples taken from the dry tops of windrows or cocks also was 1 seed in every 25, but the average proportion in 13 other samples taken from the wet, sometimes moldy or decaying bottoms of the same windrows and cocks was 1 seed in every 12. (3) The average proportion of dead or germinated seeds in 4 samples taken from the dry outsides of stacks was 1 seed in every 16; the average proportion in 4 other samples taken from wet and decomposing areas in the interior of the same stacks was 1 seed in every 4.

It is impossible to estimate the loss occasioned by unfavorable weather conditions while the clover lies upon the ground or is stored in stacks, but it must in some cases be considerable.

ROTTING OR SWEATING CLOVER BEFORE HULLING UNNECESSARY.

The writer saw one owner and operator of a clover huller hulling clover from two different fields on his own farm. The clover from one field had been cut for several weeks, during the most of which time it had lain in windrows. The seed which it yielded was inferior

in grade, by reason of the dead, brown seeds which it contained. These could probably be removed satisfactorily, but the yield would be lessened by removing them. The clover from the other field was cut three or four days before the hulling of it commenced. It was well cured; it seemed to hull about as easily as the clover from the first field, and it yielded a product practically free from dead, brown seeds. Some other farmers in the vicinity also hulled their clover from the field as soon after cutting as it was thoroughly dry, and still others cured their clover rapidly, as if for hay, and stored it previous to hulling, either in the barn or in well-covered stacks.

The best practice would seem to be to allow the clover to become as ripe as possible without loss from shelling, cut it in good, bright weather, and then protect it from exposure to rains. If a huller can be procured at once, hulling direct from the field will economize labor. If it is necessary to delay the hulling, damage and loss to the seed crop will be avoided by storing the clover in a barn or in a carefully constructed and well-covered stack.

SUMMARY.

By hard seeds is meant seeds whose seed coats are impervious to water. While such seeds remain hard, they are unable to absorb the water necessary for their germination.

In nature, nine-tenths or more of the well-matured seeds of red clover, alsike clover, white clover, and white sweet clover are hard. Hard clover seeds are sometimes of value, but are usually much inferior to good seeds which are not hard.

The hardness of well-matured clover seed is not influenced materially by conditions of soil, by seasonal variations, by climatic conditions, or by the time at which the seed is harvested.

The hardness of well-matured red-clover seed is not related to its color or size.

The rotting of clover in field or stack kills some of the seeds and may reduce the quality of the hulled crop, but it does not affect the proportion of hard seeds in the hulled crop after the dead seeds are removed.

The rotting of the clover in field or stack or sweating it in the mow before hulling is not necessary. To secure the greatest yield and highest quality of seed the clover should be cured and stored with as little wetting as possible.

The rubbing which clover seed receives in the hulling machine greatly reduces the proportion of hard seeds, but frequently breaks some of the seeds.

The clover-seed huller is, therefore, an effective scratching machine. The aim should be to have the huller so constructed and so operated as to reduce the proportion of hard seeds to the greatest possible extent and at the same time to break the smallest possible number of seeds.



FARMERS' BULLETIN



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Contribution from the Bureau of Plant Industry, Wm. A. Taylor, Chief.

GROWING HAY IN THE SOUTH FOR MARKET.

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INTRODUCTION.

The South for many years purchased much of its commercial hay from northern and western growers. The quantity and value of hay brought yearly into each of the cotton-producing States has recently been approximately determined by the Bureau of Crop Estimates. These figures, with an estimate of the increase in acreage in each State necessary to produce the tonnage now imported, are shown in Table I.

NOTE.—This bulletin is designed to furnish information on the subject of hay growing to those farmers in the South who are contemplating changing from cotton growing to some other money crop.

TABLE I.—Quantity and value of hay shipped into the Cotton States yearly.

State.	Quantity.	Value.	Increase of acreage necessary to grow the hay now brought into the State. ¹	Increase of acreage over the crop of 1914 necessary to produce all the hay consumed.
	Tons.		Acres.	Per cent.
Virginia.....	200,000	\$2,960,000	160,000	24
North Carolina.....	100,000	1,520,000	80,000	25
South Carolina.....	90,000	1,413,000	72,000	34
Georgia.....	130,000	2,119,000	104,000	41
Florida.....	80,000	1,344,000	64,000	133
Alabama.....	90,000	1,206,000	72,000	32
Mississippi.....	70,000	826,000	56,000	26
Louisiana.....	70,000	840,000	56,000	28
Texas.....	250,000	2,550,000	200,000	44
Arkansas.....	100,000	1,110,000	80,000	25
Tennessee.....	125,000	1,738,000	100,000	12
Total.....	1,305,000	17,626,000	1,044,000	

¹ Computed from the average hay production of 1.25 tons per acre.

DIFFICULTIES IN THE WAY OF PRODUCING MARKET HAY IN THE SOUTH

There must be some serious obstacles in the way of producing hay when a great agricultural section imports more than one-fifth of all the hay it uses. These difficulties should be known and well understood by every farmer before he attempts to produce market hay in the South. One of the difficulties is in the matter of curing. The South has a heavy rainfall, and rain often comes at the time of harvesting the hay crop. Weather-stained hay, unless badly damaged, is quite satisfactory for feeding farm stock, but there is a strong prejudice against it on city markets.

Another drawback to hay production in the South is the lack of suitable hay plants that will thrive under the general climatic and soil conditions which prevail over most of that area. Nearly one-half of all the hay produced in the United States consists of timothy and red clover. Neither of these plants does well in the cotton belt. Alfalfa, which forms about one-eighth of all the hay produced in this country, has not been successfully grown in the South except in limited areas.

That it is practicable for the farmers of the South to produce all the hay needed on their farms is demonstrated knowledge. There is much difference, however, between producing hay for farm consumption and for the market. For home use, cowpeas, soy beans, Bermuda grass, corn, sorghum, and a number of other fodder plants answer very well, but these crops preserved as hay do not meet the general market requirements. A hay to compete with timothy, clover, or alfalfa on the city markets must be capable of being grown readily; it must be palatable; it must offer no serious obstacles in the matter of curing

baling, and shipping; and it must be free from the danger of becoming a weed pest if the seed gets into cultivated land. If it possesses all these characteristics it may become a competitor with the standard market hays. Unfortunately, many of the most valuable southern forage crops lack one or more of the desirable qualities.

SOILS SUITABLE FOR HAY PRODUCTION.

Bottom or alluvial lands, if sufficiently drained, are especially suitable for hay production and will probably give as great a profit when used for this purpose as for any other use to which they could be put, assuming, of course, that there is a good market for hay. There are also some extensive soil areas of limestone origin that will yield abundant hay crops. It is doubtful whether it is advisable to attempt to produce market hay on either the heavy clay uplands or the sandy soils of the South. Certainly it is inadvisable to plant a large acreage for market hay on such land without previous experience as to what crops may be expected both with and without fertilizers. On such lands oats, Italian rye-grass, Sudan grass, and the Arlington mixture (orchard grass, tall oat-grass, and alsike) are most likely to succeed. The production of hay will probably become more general over the cotton-growing section, but the change will necessarily be gradual unless Sudan grass or some other new grass simplifies the problems involved.

CURING HAY.

The curing of grass hay in favorable weather is a simple process. Curing is really a combination of three processes; i. e., drying, fermentation, and bleaching. The first two processes are necessary and desirable; the third is undesirable, but in field curing it can not be entirely avoided.

To secure the best quality of hay the drying process must not be too slow. To avoid uneven drying the processes of tedding and cocking are commonly employed.

Tedding.—Tedding is simply the turning or scattering of the cut grass after it is partially dry on top. It may be done by hand with a pitchfork or, preferably, by a horse-drawn machine called a tedder (fig. 1). When the crop is very heavy, the grass is sometimes tugged when in the swath, but usually not until after it has been raked into windrows.

Cocking.—Cocking consists of putting the partially cured hay into small piles. The object is twofold: (1) It reduces the surface exposed to moisture that may fall upon it, either as dew or rain, and (2) it evens up the drying, for the reason that the relatively dry leaves continue to draw water from the moister stems. Incidentally, cocking also reduces the amount of bleaching.

In unfavorable weather the labor of curing hay is much increased as the cocks, until sufficiently dry, should be spread at each favorable opportunity and recocked again in the evening or when rain threatens. If hay that is not sufficiently dry be placed in the barn or stack it is likely to become moldy and dusty.

Cut hay should never be handled while wet with rain or dew. As the surface of the hay, if lying in the swath, is the part which was best cured before the rain, it is in the best position to dry promptly. If in the windrow, the stirring of the hay would bring the surface moisture in contact with the drier hay beneath, to which it would be readily absorbed.

Sweating.—The fermentation of hay takes place during the process of drying, and because of it the characteristic sweet odor is developed.



FIG. 1.—A hay tedder at work.

opened. The process is accompanied by the formation of heat, which is particularly noticeable in the later stages of curing in the cock, the stack, or the mow. This final stage of fermentation is called sweating. The process of sweating continues for a considerable period, and hay should never be baled until the sweating has ceased. For any reason curing be long protracted the hay becomes bleached or weather stained and loses most of its aroma.

Curing legumes.—Legumes, with the exception of lespedeza, are far more difficult to cure than grasses. This is due largely to the solid, more succulent stems, and to the fact that the leaves shed readily if the curing process is delayed, so that much of the leafage, the most nutritious part of the hay, is lost. Furthermore, legume hay absorbs rain or dew more readily, both in the windrow and

the cock. Finally, legume hay is very apt to heat excessively in the sweating process if put in the stack or mow when not sufficiently cured. This heating is often sufficient to char the hay in the center and sometimes to cause fires. Legume hay should therefore never be put into a barn when half cured.

Complete curing.—Curing may be considered completed when the stems are apparently dry. At this stage a wisp of the hay breaks readily when it is tightly twisted in the hand and is dry enough to rattle if violently shaken.

SPECIAL DEVICES FOR CURING HAY.

To hasten the drying of hay and to prevent the injury of half-cured hay by rain, several devices often used are helpful, but each necessitates additional labor.

Hay caps.—Various forms of hay caps to protect cocks from rain have been used. The simplest is a piece of canvas about 12 feet square with a weight at each corner.

Perches.—A perch is simply a pole or stake driven into the ground and the green or half-dried plants are hung upon it so as to make a tall, narrow cock. Perches are much used in curing peanuts and cowpeas.

Pyramids.—A pyramid consists of three or four legs, usually 6 to 8 feet long, pointed at the top and commonly sharpened below so they can be fastened firmly in the ground. Crosspieces joining the legs are so useful. A pyramid permits the building of rather large cocks with a hollow space in the middle, which helps greatly in drying the hay. The accompanying illustration (fig. 2) shows a form of pyramid for curing legumes devised at the Tennessee Agricultural Experiment Station.

The objection to all of these devices is the additional labor and cost involved. They are more useful for legumes than for grasses.

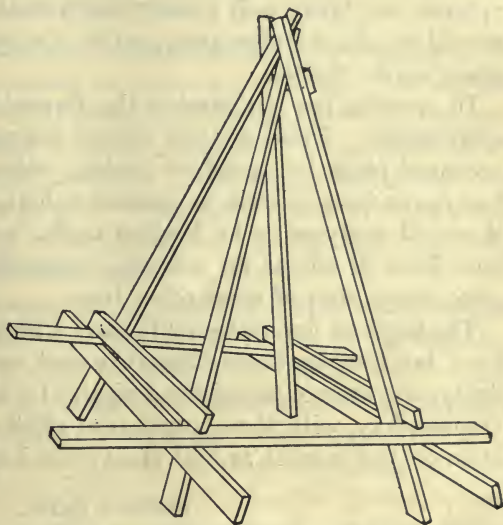


FIG. 2.—The Tennessee pyramid for curing legumes, especially soy beans and cowpeas. This consists of two A-shaped frames, so constructed that the top of one locks into the top of the other. Horizontal strips nailed at the base of these frames support loose crosspieces, to keep the vines off the ground. This may be constructed of poles or of 1 by 3 inch pieces 6 feet in length. The advantage of this curing frame over most others lies in the fact that it can be taken apart and stored in a small space.

CROPS SUITABLE FOR MARKET HAY THAT MAY BE GROWN IN THE COTTON BELT.

There are a few grasses and legumes adapted to southern conditions that make good market hays. Lespedeza in the lower Mississippi Valley, Johnson grass over most of the cotton belt, Bermuda grass on the rich bottom lands, alfalfa in certain limited areas, and the Arlington mixture (orchard grass, tall oat-grass, and alsike) on the heavy uplands are fairly well known and valuable hay crops. To this list should be added Sudan grass, which is showing much promise as a hay grass for the South.

In growing hay for market the farmer must know the market requirements. These do not always correspond with the commonly accepted ideas in regard to feeding values. For instance, timothy has never been shown to possess a high nutritive value, either by chemical analyses or by feeding trials, but its palatability and freedom from ill effects on animals, especially horses, give it a market price above that of most other hays.

The legumes unquestionably have a higher feeding value than grass hays, but they are more difficult to cure, are liable to mold and become dusty, and are not especially desirable for horses, at least to feed alone. Legume hay, with the exception of alfalfa, seldom sells for as high a price on the market as first-class grass hay.

JOHNSON GRASS.

Johnson grass is so well known in the South that little need be said concerning its culture. Where once established it is not easy to eradicate it, and on this account the plant has a bad reputation as a weed. Its ill repute as a weed has led to its good qualities as a hay plant being underestimated. Its reputation as a weed also reduces its market value for hay, as many feeders fear to use it because of the practical certainty of getting seed into the manure.

Whether a southern farmer should ever sow Johnson grass on land not already occupied by it is very doubtful. North of the Potomac and Ohio Rivers Johnson grass nearly always winterkills and so does not become troublesome as a weed. In the South, however, it is not easy to eradicate.

On land already covered by Johnson grass many southern farmers reap profit by cutting it for hay. Indeed, in some sections Johnson grass hay is an important crop.

Johnson grass is best sown in March or early in April, using from 1 to 1½ bushels of seed per acre. It makes very little growth on light sandy soils. Unless established meadows are plowed every year the yield of hay becomes much reduced and after the second year is very small. For this reason the best practice is to plow Johnson grass

he fall and sow to oats or oats and hairy vetch. A crop of oats or oats and vetch hay can then be cut the following spring, followed by one or more cuttings of Johnson-grass hay later in the season. Johnson grass has proved a very satisfactory hay for city horses, many very men considering it practically as good as timothy for this purpose. Its weedy habit and perhaps prejudice make its price on the market much lower than that of timothy.

BERMUDA GRASS.

Bermuda grass is well known throughout the cotton region. On most soils it is valuable primarily as summer pasturage. On alluvial and other rich soils, however, it grows tall enough to cut for hay and may be mowed two or three times in a season. On account of its dense growth and abundant leafiness, Bermuda grass yields very heavily in proportion to its height. Ordinarily it will average about a ton of hay per acre to a cutting, but double this yield has been obtained under exceptional conditions.

Tracy found at the Mississippi Agricultural Experiment Station that work mules did as well on Bermuda-grass hay as on timothy. The feeding value of the two hays for horses is probably about equal. Bermuda-grass hay, however, has no fixed status on the market, more of it being thus used in Louisiana than in any other State.

Bermuda grass is easily propagated by planting pieces of rootstocks or of the sod. The rootstocks may be chopped up in a cutting box and sown broadcast on well-prepared ground, covering with a disk or a common harrow. In some instances the sod itself is used. When an old field is plowed up, the sod can be torn into shreds and used in starting a new field by throwing pieces into the furrow after the plow and covering with a harrow. To save the loss of the land while the Bermuda grass is starting, it may be planted in the rows of any intertilled crop after the last cultivation. It does not thrive, however, if too densely shaded.

Seed of Bermuda grass is now grown in Arizona and this is of much better quality than that formerly on the market. The seed is very fine and rather high priced; therefore, the seed bed should be well prepared and firmed in order to avoid too deep sowing. The seed should be sown at the rate of 3 to 5 pounds per acre and covered with a roller. The best time to sow it in the extreme South is in February or early in March; farther north, in March or April. To scatter the seed more evenly it is well to mix it with meal or soil so as to make a larger bulk.

Lespedeza is the only summer crop that succeeds well in combination with Bermuda grass.

LESPEDeza, OR JAPAN CLOVER.

Lespedeza is a Japanese annual legume now generally distributed through the South. Over most of its range it does not grow tall enough to cut for hay, but it is highly esteemed for the pasture it gives in summer and fall. In the bottom lands of the Mississippi Valley from Memphis south and on the richer upland soils of Louisiana and Mississippi lespedeza has for many years been an important hay crop. It is scarcely advisable to cut it for hay unless it is more than 7 or 8 inches high. On very rich soils it becomes 18 inches or, rarely, 24 inches high. The yield of hay varies from 1 to 3 or, rarely, 4 tons per acre.

Lespedeza usually continues to volunteer abundantly when once established, especially if used only for pasture. If cut for hay it is better to sow the seed than to rely entirely on volunteer crops. The usual rate of seeding is 15 pounds of hulled seed to the acre. The best practice is to sow the lespedeza seed in early spring, February or March, in fall-sown oats. The oats are harvested for grain, after which the lespedeza will produce a crop of hay, which is usually cut in October.

Lespedeza hay is now much used in the regions where it is grown both for cattle and for city horses. About 10 per cent of the commercial hay sold in New Orleans is lespedeza.

For detailed information on lespedeza culture, see Farmers' Bulletin 441, entitled "Lespedeza, or Japan Clover."

COWPEAS.

Cowpeas make excellent hay, comparable in feeding value to alfalfa. The plant is, however, coarse and difficult to cure so as to make bright hay. Cowpea hay is much better suited for feeding cows than for horses. Partly on this account and partly because of its coarseness and great unevenness in quality, cowpea hay has but little standing on the city markets. The same remark also applies to soy-bean hay.

For detailed information concerning these crops, see Farmers' Bulletins 318, entitled "Cowpeas," and 372, entitled "Soy Beans."

OATS.

Oats that are nearly ripe are often harvested in the South and fed in the bundle to farm animals. In the West, oats are often cut in the early dough stage for hay, but such hay is not well known in the South. There seems to be no valid reason why large quantities of oat hay should not be grown in the South and thus diminish the importation of timothy hay. As winter oats succeed well everywhere in the cotton belt, the growing of this hay presents no new problem.

For detailed information on the culture of oats, see Farmers' Bulletin 436, entitled "Winter Oats for the South."

ITALIAN RYE-GRASS.

Italian rye-grass has about the same adaptations as rye or winter oats. Culturally it must be considered an annual, but individual plants will live two years or more. Sown in the fall it will make one crop of excellent hay early in summer. In Europe it is much esteemed and more than any other grass makes the commercial hay of Europe. Its growth is vigorous and rapid, and it will yield on the average $1\frac{1}{2}$ tons of hay per acre in a single cutting, which is all that will ordinarily be obtained in the South, as it languishes in hot weather. The hay is of the highest quality for horses, and when well known should command the same price as timothy. This hay is already grown to a considerable extent in the South Atlantic States.

Italian rye-grass prefers sandy or sandy-loam soils, but thrives well in clay loams. Following it a crop of cowpeas can be grown the same season.

Seed of the Italian rye-grass may be obtained of the larger houses handling imported seed. Although most of the seed used in this country at the present time is produced in Europe, the price is reasonable, ranging from 6 to 12 cents per pound. A bushel of the seed weighs about 24 pounds, and from 20 to 30 pounds are required to sow an acre. This grass is almost invariably sown without a nurse crop. The ground should be prepared for seeding by a deep plowing and then leveled by a thorough use of a disk or smoothing harrow. The continued use of the spike-tooth harrow until the ground is well settled is advisable. No other one thing is the cause of so many failures in seeding grasses as a loose seed bed. When the soil is thoroughly firmed, the seed may be sown broadcast and harrowed in or seeded with a grain drill. It should be covered to a depth of half an inch to 2 inches, depending on the nature of the soil. In a heavy clay soil the covering should be extremely light, while in a loose sandy soil so much care need not be exercised.

ARLINGTON MIXTURE OF ORCHARD GRASS, TALL OAT-GRASS, AND ALSIKE.

The Arlington mixture consists of 10 pounds of orchard grass, 20 pounds of tall oat-grass, and 4 pounds of alsike for every acre. On the red upland soils of the South this is the only combination of northern grasses which can be recommended for a perennial meadow. It will produce satisfactory crops on soils where timothy and red clover are wholly unsatisfactory. At Arlington Farm, Va., this hay proved satisfactory in every way for horses and when well known should command a good price in the city markets.

Prejudice exists against orchard grass because it is rather coarse and against tall oat-grass because of its supposed unpalatability. Both of these objections are apparently not founded on any real basis. A more serious objection is the rather high cost of seeding per acre,

but where this mixture will make a good perennial meadow this point is of little consequence.

The seed should be sown in early fall or in early spring, preferably the former. Late fall seedings are inadvisable, as very young orchard grass frequently winterkills.

ALFALFA.

Alfalfa hay is one of the most nutritious and palatable of feeds for all classes of farm animals. In chemical composition it resembles clover, cowpeas, and allied legumes in having a high protein content, but it slightly outranks any of these that are now under cultivation in both total and digestible protein. Under favorable conditions several cuttings are procured in a season, thus making the total tonnage per acre somewhat greater than that produced by other legumes.

As regards soil requirements alfalfa is a most exacting plant, and while it may be made to grow under a wide range of soil conditions it is only in favorable locations that its production on a commercial basis becomes profitable. In general, the limestone soils are especially well suited to alfalfa. This is particularly true of the "black lands" of Alabama, Mississippi, and Texas. Certain of the well-drained river bottoms, particularly those that contain a considerable admixture of material from limestone regions, also produce profitable yields of alfalfa. On some of the Piedmont soils, such, for instance, as the Cecil clay loam in the vicinity of Rock Hill, S. C., alfalfa may be grown at a profit. As a whole, however, the Piedmont soils can not be recommended for the production of alfalfa as a market hay, on account of the uncertainty and expense encountered in establishing and maintaining a stand in that region. This statement also applies with equal or somewhat greater force to most of the Coastal Plain soils.

One of the chief drawbacks to the production of alfalfa for hay is the difficulty encountered in curing. The market demands a pale green hay, and this color is often difficult to secure on account of the heavy precipitation in the spring and early summer months. The first and sometimes the second cutting comes when rainy days are likely to be frequent, and a great deal of care is necessary in saving these first cuttings in good condition.

As much of the hay grown in this region is liable to be more or less discolored in the process of curing, it can not compete successfully with the brighter colored hay from the Western States. Under the present conditions, the practice of growing the crop in connection with dairying or hog raising is highly advisable, making the sale of the surplus hay a secondary consideration. That portion of the crop which is sufficiently discolored to injure its sale should be fed on the farm, and its feeding value may be only slightly less than that of the bright

colored hay. Only the brightest colored portion of the crop should be put on the market.

Alfalfa hay when well cured always finds a ready market but ordinarily does not command quite as high a price as No. 1 timothy.

For detailed information on the culture of this crop, see Farmers' Bulletin 339, entitled "Alfalfa."

SUDAN GRASS.

Sudan grass is so recent an introduction that there is yet but a limited amount of information as to its value for a market-hay grass in the South. The present evidence indicates, however, that it is likely to be an important factor in the hay problem. While the grass is an annual, it may be cut two or three times in a season. The hay is comparatively coarse but so palatable that animals eat it very eagerly. The average yield per acre at Arlington Farm, Va., in three years has been 3.4 tons of hay from one cutting. At more southern experiment stations the following yields per acre have been secured: Jackson, Tenn., 2.6 tons; Agricultural College, Miss., 5.5 tons; Baton Rouge, La., 3.3 tons; Athens, Ga., 3.6 tons; Fayetteville, Ark., 1.1 tons; Chillicothe, Tex., 3.9 tons; Stillwater, Okla., 2.9 tons.

Sudan grass may be sown in the South as late as July 1 and still have ample time to grow a full crop of hay. Indeed, in some parts of the South late sowing may be desirable, as it will insure better average weather for curing. If, however, the seed is sown earlier, the second cutting will come in the early fall, and there is perhaps an even chance of good curing weather for the first cutting.

The seed may be sown broadcast or drilled, which requires about 10 pounds of seed per acre, or in cultivated rows $3\frac{1}{2}$ feet wide, for which purpose 3 to 4 pounds is sufficient. When grown in rows the hay will be somewhat coarser.

For mixtures with cowpeas or soy beans Sudan grass is most excellent. It is stout enough to support the legumes, and the mixture is much more easily cured than either legume alone. The hay, too, is of higher feeding value than Sudan grass alone, but the mixture is better for cows and colts than for horses.

Owing to the remarkable demand for the seed of Sudan grass the price is very high. There is every reason to believe, however, that later the seed will be cheap, as the yield per acre is very large.

In the cotton belt a minute insect destroys the seed while forming. On this account commercial seed will be grown mainly in regions where this insect does not occur.

To what extent Sudan grass may prove to be a popular market hay remains to be seen, but the chances seem greatly in its favor.

More than all other plants Sudan grass promises to solve the problem of market hay over most of the South.

For detailed information concerning this grass, see Farmers' Bulletin 605, entitled "Sudan Grass as a Forage Crop."

EQUIPMENT FOR A SMALL HAY FARM.

The equipment for a small hay farm, 20 acres or more, besides the ordinary implements of tillage, should consist of a mower, a hayrack, a wagon with frames or racks, some pitchforks, and a hay tedder. (See figs. 1, 3, 4, and 5.)

The mower, rake, and tedder constitute the most expensive part of hay machinery, and the advisability of purchasing such implemen-



FIG. 3.—Mowing machines at work.

when they can not be rented depends directly upon the acreage grown and the care given them while not in use.

The cost per unit of production for mowers and rakes diminishes as the quantity of hay cut each year increases. This is well brought out by an investigation conducted by H. H. Mowry, of the Office of Farm Management. Records of over 600 mowing machines were obtained in a hay-growing section and grouped according to the size of the farms on which the mowers were used. One group included farms that had an average annual hay production of 13.8 acres, a second of 38.8 acres, and a third of 88.8 acres. The average length of life for a mower for these three groups was 16.1 years on the small farms, 14.6 years on those of medium size, and 11 years on the large farms. The size of the mowers, as measured by the width of the

ter bar, increased with the size of the farms, being 4.9 feet, 5.4 feet, and 6.4 feet, respectively, for the three groups. The average original cost was \$40, \$42, and \$47.50. The total cost of these mowers, including the original cost, 6 per cent interest on the investment, and repairs, made the average cost for each acre of hay cut 36 cents for the small, 17 cents for the medium, and 10 cents for the large farms. The hayrakes used on these three groups of farms varied in width from 8.6 feet for the smallest to 9.9 feet for the medium and 11.4 feet for the largest, the average original cost being \$22, \$24, and \$26, respectively.

The cost for each acre of hay raked, including the original cost of the rake and 6 per cent interest on the investment and repairs, was



FIG. 4.—A hayrake at work.

5 cents on the small, 7 cents on the medium, and 4 cents on the large farms.

Estimating the yield of hay at $1\frac{1}{2}$ tons per acre, the cost per ton for both mower and rake would be 34 cents for the small, 16 cents for the medium, and 8 cents for the large farms.

No data are available on the overhead cost of a tedder, but it seems reasonable to suppose that it is about twice as expensive as rake.

HAY-HANDLING DEVICES.

The profitable production of hay depends a great deal on the substitution of horse labor for man labor. Much of the modern haying equipment, such as loaders and stackers, is too expensive for any but

very large hay farms. These should be purchased only after careful investigation of them in operation. There are, however, some cheap devices that every hay producer should have. Even the small hay farm should be equipped with a horse fork (fig. 6) and the necessary rope pulleys for its operation. Such an equipment, costing about \$15, is almost indispensable either for stacking hay or putting it into a barn.

Stacking hay.—One of the simplest stacking arrangements is the tripod support (fig. 7), which can easily be made by bolting together at the top three timbers 30 or more feet in length. An ordinary hay poon fork may be used, its rope operating through a pulley suspended from the top of the tripod. A single pole with a swinging arm supported by three stay wires (fig. 8) is easily built and often used.



FIG. 5.—Loading hay. A good wagon fitted with a hay frame is essential to economical hay production except on large farms where hay stackers are used. Hay cocks with caps are shown in the background.

A little more complicated and expensive but more satisfactory arrangement is a wire cable supported in the air, over which a traveling carrier operates (fig. 9). If there are two large trees convenient for supporting the cable, the erection of this system is extremely simple. It may, however, be put up in an open field, supporting each end of the cable with two timbers crossed and bolted together at a point about a foot from their upper ends. The lower ends of these supports are spread out at the bottom to prevent the swaying of the cable. The cable must be drawn taut and the ends securely anchored to trees or to the ground. In the absence of anything else to which the cable may be fastened, anchor blocks buried 3 or 4 feet beneath the surface may be used. Larger stacks can be built with the cable than with the tripod arrangement.

A stack built with the use of a horse fork will usually keep the hay in better condition than if built by the old method, where the hay is pitched on the stack by hand. These stacks may be made taller and larger, thus reducing the proportion of surface exposed to the weather. The hay is dropped by the horse fork directly in the middle of the stack, and this guards against the stack tipping to one side on settling. It also insures keeping the center of the stack full and well compacted, which is the main factor in successful stacking. As the stack settles, the outside drops more than the center and thus sheds the rain better.

A stack is at best but a poor substitute for a barn or a hay shed in a humid climate and should be regarded as a makeshift (fig. 10). A hay shed need not be expensive. Any kind of shed, provided the roof does not leak, will do. Side boards extending down 5 or 6 feet from the eaves will prevent rain from being blown in on the hay after it has settled away from the roof. There will be very little damage on the exposed sides.

In building a barn or hay shed provision should be made for using a horse fork. The simple arrangement shown with the tripod stacking device (fig. 7) can be adjusted to work in almost any barn. It is better, however, to have a steel or wooden track suspended under the ridge, on which may be operated a hay carrier. This system, however, necessitates an open central framework of the barn or shed.

The cross timbers should be at least 12 feet below the track, in order to leave room for the loaded fork to pass.

SIZE OF STACK BOTTOMS.

Hay near the bottom of a stack will spoil unless there is some foundation to keep it off the ground. Stack bottoms are best made of two layers of poles or old rails. It is important to make the bottom of the right size. A stack 14 feet wide, 15 feet high, and 20 feet long, measured before it settles, will contain about 5 tons, every increase of

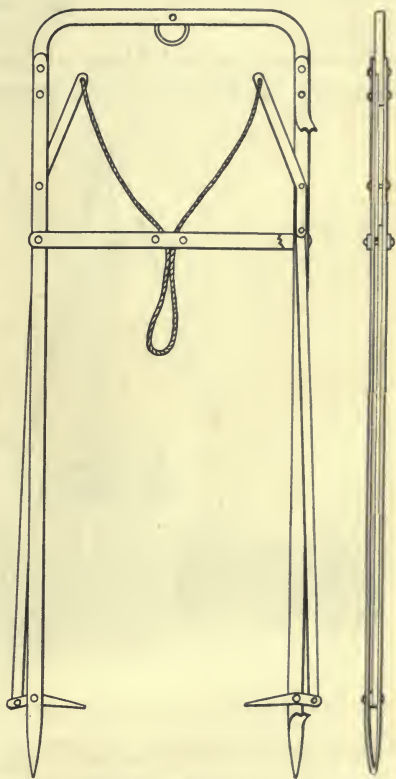


FIG. 6.—A double-harpoon hayfork, used for unloading hay. Figures 7 and 8 show this fork in use.

4 feet in length increasing the capacity of the stack by 1 ton. Stack 16 feet wide, 17 feet high, and 20 feet long will contain about 7 tons each increase of 4 feet in length increasing the capacity by $1\frac{1}{4}$ tons. The smaller dimensions are common where the hay is pitched off the wagon by hand; the larger where stacking devices are used.

For detailed information in regard to the size and capacity of hay stacks, see the paper in Circular 131 of the Bureau of Plant Industry entitled "Measuring Hay in Ricks or Stacks."

HAY PRESSES.

There are several kinds of hay presses on the market. Among them are hand presses, box presses, 1-horse presses, 2-horse presses and power presses.

Three kinds of bales are made: Box-pressed bales, round bales, and perpetually pressed bales. The perpetually pressed bale is the only kind in demand on the southern markets, and therefore only presses that make this sort of bale (the 1-horse, the 2-horse and the power press) need be considered here. The first-mentioned press is not economical, on account of its small capacity.



FIG. 7.—Stacking hay, showing a tripod with a horse fork in use.

The cost of a 2-horse press is \$150 to \$300 and of a large power press from \$500 upward.

One of the most convenient and efficient 2-horse presses now used is of the continuous-travel type that gives three impulses to the plunger to each revolution of the team and is so arranged that the hay is fed into an opening on the side or top of the press. As soon as a forkful of hay is placed in the press, the feed opening closes and the hay is carried down into the baling chamber. Hence, there is no necessity to force the hay down by means of a fork or the foot as with some of the older types of presses.

One very efficient type of power press is provided with a self-feeding attachment composed of an endless apron conveyor and pickers that

tribute the hay evenly. The hay is then carried down to the baling chamber and forced into place by a mechanical arm.

For detailed information on baling hay, see Farmers' Bulletin 508, entitled "Market Hay."

DESIRABILITY OF OWNING A HAY PRESS.

The total tonnage to be baled in a single season should be the deciding factor when considering the purchase of a hay press. It is doubtful whether it will pay a grower to purchase even a 2-horse press if he has less than 50 tons of hay to be baled each year. When



FIG. 8.—A single-pole stacker.

less than this quantity is grown it will be cheaper to hire the hay pressed if it is possible to do so. Where there are several hay growers in the same community, each growing small quantities of hay, it is best to purchase a press in common, or else for one person to purchase and make a business of baling hay, a frequent practice in most hay-growing sections.

A 2-horse press can be operated with four or five men and will bale 8 to 12 tons a day. A large power press will require about twice the crew of a 2-horse press, and consequently when a breakdown occurs there will be a relatively greater loss of time.

A power press will prove profitable only when a large acreage grown by one individual or where there is considerable hay grown in the locality. Such a press should bale 20 to 30 tons a day. Unless there are at least 200 tons to be baled the 2-horse press is advised.

BALING HAY.

Hay should be put up in neat, uniform, square-ended bales, properly wired, and with distinct folds or layers of approximately the same size and easily separable. Hay thus baled will always command a better price than slovenly baled hay, and especially on a crowded declining market.

Properly made bales possess evident advantages. If uniform in length more can be packed in a car. If square ended they are liable to fall apart and thus cause loss to the shipper. If made



FIG. 9.—Stacking hay, showing one of the best stacking devices. This makes the construction of large ricks or stacks feasible.

of many folds or layers, a small quantity for feeding is convenient and easily separated from the bale.

To make a good bale, care should be exercised to make each forkful uniform and not to feed very large or very small forkfuls at random. Special attention should be given when starting or finishing a bale in order to secure square ends. The division block should be dropped at the proper moment, thus insuring bales of uniform length.

Another very important point is to put only one kind or grade of hay into a bale. The custom of "sandwiching," or putting one grade of hay between two grades of better hay, usually results in a much greater financial loss than the mere value of the hay. It causes the shipper or receiver to be always on the lookout after he has once seen hay from a grower who tries to dispose of his spoiled hay by this method.

BALING FROM THE FIELD.

Hay is sometimes baled directly from the windrow or from the stacks. This practice is not a desirable one in humid regions, there being increased danger of loss from rains and inevitably a greater amount of bleaching. The most serious difficulty, however, is that hay from the field is often baled too soon. It may appear sufficiently dried, but on close examination it will be found that only the leaves are dry enough, while the stems are still sappy. After such hay is baled it will go through the process of sweating, and often on arrival



FIG. 10.—A group of small stacks, showing an enormous waste of hay. All of this hay should have been put in one or two stacks. A hay shed would soon pay for itself on this farm.

the market will be found so hot and consequently damaged as to be classed as "no-grade" hay.

The evident advantage of baling from the field is to save the cost of stacking or of housing, but this advantage in reducing expense rarely compensates for the poorer quality of hay that is the usual result.

BALING FROM THE STACK OR BARN.

After hay has been stacked or housed it goes through the process of sweating, which requires five to eight weeks. This delay sometimes prevents a grower from taking immediate advantage of a good market, but on the other hand it insures a better quality of hay. After hay has gone through the sweat there is practically no danger of heating in the bale. Unless the circumstances are unusual, hay could not be baled before the process of sweating is complete.

SELLING HAY IN LOCAL MARKETS.

The most satisfactory method of marketing, especially by the beginner, is to sell on the local market. In so doing the producer and consumer come into personal contact and a definite understanding as to the quality or value of the hay may be reached. The question of grades, as they are known in the city market, is eliminated, and there is little need to discuss grades or to sell hay on grade, because the consumer is present and can inspect the hay and form his own opinion as to its value.

SELLING HAY IN CITY MARKETS.

The safest method of disposing of hay to be consumed in the city is to sell it direct, where possible, to the country shipper. By this method the grower is relieved of any further trouble or worry concerning the final selling of his hay.

In case the producer ships to the city market it is very advantageous to him to become acquainted thoroughly with each market in respect to the size and weight of bales preferred, the kinds of hay which are most popular, and the grade of hay demanded. This is necessary in order to avoid rejections when shipped on grade, and to prevent disputes, adjustments, possible lawsuits, and loss of money. The demands of the more important city markets are shown in Table I.

SIZE AND WEIGHT OF BALES.

Hay should always be baled in the sizes and weights most used, and especially in the size and weight most in demand in the particular market where it is to be sold.

The sizes of bales in general use are as follows:

Dimensions of small bales.....	{14 by 18 by 36 inches. 16 by 18 by 36 inches.
Dimensions of medium bales.....	{17 by 22 by 36 inches. 18 by 22 by 36 inches.
Dimensions of large bales.....	22 by 28 by 46 inches.

Bales are classified by weight as follows:

Small bales.....	60 to 100 pounds.
Medium bales.....	100 to 150 pounds.
Large bales.....	150 to 250 pounds.

REQUIREMENTS OF SOUTHERN HAY MARKETS.

In Table II are shown the kinds of hay usually sold and the size of bales most in demand in various southern cities as shown by investigations conducted in 1910 and 1911. In general, hay is received and sold in private warehouses. In New Orleans and Savannah, however, this business is transacted in a terminal warehouse.

TABLE II.—*The requirements of various southern markets with respect to the kind and character of hay offered for sale and the type of bales used.*

City and kind of hay sold.	Type of bales demanded, in order of preference.	Common faults that affect the price of the hay received.
Atlanta, Ga.: Timothy, alfalfa, $\frac{1}{2}$ Bermuda grass, Johnson grass, millet, corn shucks.	Small (70 to 100 pounds), medium 3-wire (150 pounds).	
Augusta, Ga.: Timothy, Johnson grass, Bermuda grass, native mixed.	Small (80 to 100 pounds), large 5-wire (200 pounds).	Johnson grass very often cut too late.
Birmingham, Ala.: Timothy, alfalfa, Johnson grass, light timothy mixture.	Small (80 pounds).....	Local-grown alfalfa often improperly cured.
Chickston, S. C.: Timothy, timothy and grass mixture.	Small.....	Timothy often cut too late, has reddish color, and is mixed with briers and grasses.
Concord, S. C.: Timothy, Bermuda grass, Johnson grass.	Small (16 by 17 inches), large (18 by 22 inches).	Timothy often cut too late, has red color, and contains trash and weeds.
Worth, Tex.: Johnson grass, prairie hay, alfalfa, "coast" hay.	Small (60 to 80 pounds).....	First crop of Johnson grass often cut too late and improperly cured.
Easton, Tex.: Texas prairie, Johnson grass, alfalfa, "coast" hay, timothy.	do.....	Cane and Johnson grass cut too late; prairie has reddish color caused by being cut too late.
Easton, Tex.: Johnson grass, prairie, alfalfa, "coast" hay.	do.....	Do.
Meriden, Miss.: Timothy, alfalfa, light clover mixture.	Small.....	Local-grown alfalfa off color and improperly cured.
Monroeville, Fla.: Timothy, light clover mixture.	Medium (70 to 125 pounds), small (70 to 90 pounds).	Medium bales should have three wires; little demand for the lower grades.
Mountain Rock, Ark.: Prairie, alfalfa.....	Small (60 to 80 pounds).....	Red color in prairie hay is the most common fault found with hay in this market.
Orlando, Ga.: Timothy, clover.....	Small (80 to 100 pounds), large 5-wire.	Local-grown hay often of poor color.
Memphis, Tenn.: Timothy, clover mixture, prairie, alfalfa.	Small (60 to 100 pounds).....	Sandwiched cars and bales often received; considerable hay off color; demand for timothy of better grades only.
Mobile, Ala.: Timothy, alfalfa.....	Small (80 to 100 pounds).....	
Montgomery, Ala.: Johnson grass, timothy, alfalfa, Bermuda grass.	do.....	Large quantities of low-grade timothy received in the past have caused this kind of hay to cease to be in very great demand.
New Orleans, La.: Timothy, prairie, alfalfa, clover mixture, clover, lespedeza.	Small, large.....	A large percentage of hay grades low, on account of being too mature and improperly cured.
Richmond, Va.: Timothy, light clover mixture, clover.	Small, medium (100 to 125 pounds).	Timothy often cut too late, has reddish color, and is mixed with briers and grasses.
St. Acola, Fla.: Timothy, alfalfa.....	Small (80 pounds).....	More low-grade hay received than in demand.
High Point, N. C.: Timothy, native.....	Small (125 pounds), large....	Timothy often cut too late, has reddish color, and is mixed with briers and grasses.
Annah, Ga.: Timothy, prairie, alfalfa.....	Small (90 pounds), large....	Timothy often mixed with redtop, other grasses, and weeds.
Seaside, La.: Timothy, alfalfa, prairie, Bermuda grass.	Small (60 to 70 pounds), 14 by 18 inches.	Local-grown alfalfa off color and improperly cured.
St. Paul, Fla.: Timothy, prairie, clover.....	Small (90 to 100 pounds), medium (120 to 150 pounds).	Medium bales should have three wires.
Wilmington, N. C.: Timothy, clover.....	Small (125 pounds), large....	Timothy often cut too late, has reddish color, and is mixed with briers and grasses.

More detailed information on the subject of market hay will be found in Farmers' Bulletin 508, previously cited.

All of the publications mentioned in this bulletin, except Circular 131 of the Bureau of Plant Industry, the edition of which is exhausted, will be sent free of charge on request to the Secretary of Agriculture, Washington, D. C.

SUMMARY.

(1) More than one-fifth of all the hay used in the South is shipped in from other parts of the country.

(2) Growing hay for market in the South is a profitable business where the soil conditions are favorable for production.

(3) The heavy clay uplands and the sandy soils along the coast are not well suited for market-hay production.

(4) The special equipment necessary for the successful production of market hay consists of a mower, rake, tedder, wagon with frame horse fork, pitchforks, and a hay press.

(5) The maintenance charge for hay-making equipment is so high that it is doubtful whether a farmer is justified in going into the business and incurring the expense unless he has 20 acres or more of hay to cut each year.

(6) Unless a farmer has 50 tons or more of hay to bale each year he had better hire the hay baled than purchase a press.

(7) Where several farmers in one community raise small quantities of hay they should purchase a press in common, or else one should buy the press and make a business of baling for the others.

(8) There is less loss from damaged hay in large stacks or ricks than in small ones, but a stack at its best is a makeshift in a humid climate. Every one going into the business of producing market hay in the South should have barns or hay sheds in which to store the crop.

(9) The most serious difficulties in the way of producing market hay in the South are (1) the lack of plants adapted to the soil and climate that will make a hay capable of competing with timothy, red clover, and alfalfa, and (2) the danger of rainy weather during the period of curing the crop.



FARMERS' BULLETIN



WASHINGTON, D. C.

678

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Contribution from the Bureau of Plant Industry, Wm. A. Taylor, Chief.

GROWING HARD SPRING WHEAT.

by CARLETON R. BALL, *Agronomist in Charge*, and J. ALLEN CLARK, *Scientific Assistant, Western Wheat Investigations, Office of Cereal Investigations.*

FOREWORD TO THE FARMER.

Many questions are asked each year about the growing of spring wheat. You who are farming in the Great Plains area have asked what methods or what varieties are better than those you are using. Those who are thinking of locating in this area have asked what portions are adapted to the growing of wheat and how it may best be grown.

This brief bulletin is intended to answer some of these questions about the growing of spring wheat. Another bulletin will contain brief descriptions of the best varieties and tell where they are best adapted.

As we all know, agriculture in this area is still in the early stages of development. This means simply that the farming is done on a large scale and with few crops. Such a system nearly always develops in a newly settled area under pioneer conditions. This should not necessarily be called poor farming. The cropping methods used are, as a whole, well suited to this extensive kind of farming.

The early settler must grow the crops that are quickly and profitably produced with little equipment. He usually has rather limited means. Frequently there is but little knowledge of what cropping methods will prove best in a new part of the country.

For these reasons, among others, wheat is still grown here on the extensive scale which especially marked the early development of this area. In those districts of the Plains which have been longest settled, the type of farming is slowly changing to a more diversified system.

NOTE.—This bulletin discusses the topographic, soil, and climatic features of the northern Great Plains, with special reference to the production of hard spring wheat in that area. Cultural methods for growing the crop are given.

Much of the area under discussion has been converted from range by the present generation of farmers. Its western portion even now the frontier—the scene of ceaseless and often severe struggle between the settler and the forces of nature. Added to the handicaps often are those of scattered settlement, the lack of schools and social facilities, and the distance from market.

This paper is prepared especially for the new settler, not acquainted with the soil and climate or the general methods of wheat production in his new home.

OUR LARGEST SPRING-WHEAT FIELD.

Out in the northern part of the Great Plains area lies Uncle Sam's great field of spring wheat. It covers the Dakotas and Minnesota

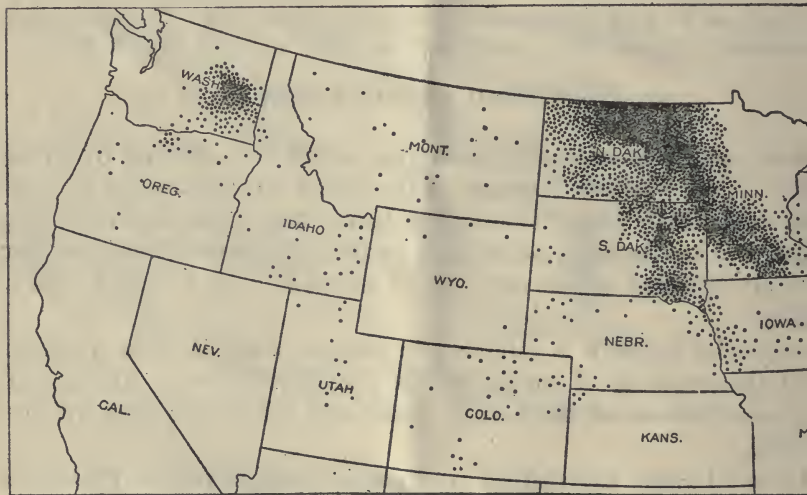


FIG. 1.—Map of the northwestern United States, showing where common spring wheat was grown in 1909. Nearly all of it is the hard spring wheat of the northern Great Plains area. Each dot represents 5,000 acres. (Figures from the Thirteenth United States Census, 1909.)

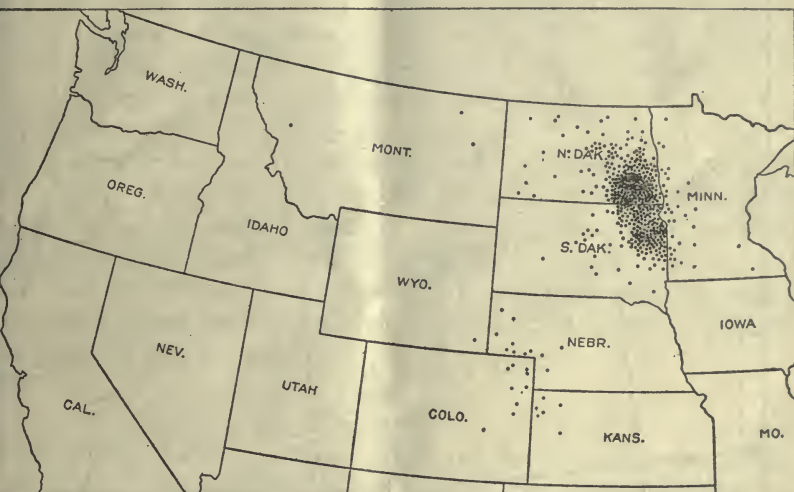
like a mustard plaster. Its edges overlap the surrounding States of Iowa, Nebraska (also northwestern Kansas and northeastern Colorado), Wyoming, and Montana. The three prairie provinces of Canada are covered by a very similar field.

Our great field contained in 1909 about 17 million acres of hard spring wheat, of which nearly 16 million acres were in the Dakotas and Minnesota. This was more than one-third of the total wheat acreage of the United States in that year.

As most of us know, there are two distinct kinds of hard spring wheat—common wheat and durum (macaroni) wheat. Of the nearly 17 million acres of hard spring wheat about six-sevenths are common wheat (fig. 1) and one-seventh durum wheat (fig. 2).

South of the big field of hard spring wheat is an equally large field of hard winter wheat, with Kansas as its center. The two fields naturally overlap to some extent. Wherever winter wheat can be easily grown it is more satisfactory and more profitable than spring wheat.

The boundaries of the winter-wheat field are being slowly extended to the north and west. The expanding of the spring-wheat field is mostly to the westward, as the cattle range gives way before the nearer farmer.



2.—Map of the northwestern United States, showing where durum spring wheat was grown in 1909. Note that nearly all of it is grown in the very center of the common spring-wheat area. Each dot represents 5,000 acres. (Figures from the Thirteenth U. S. Census, 1909.)

WHAT IS THE NORTHERN GREAT PLAINS AREA?

SIZE.

Most of us think of the Great Plains area, and rightly, too, as a nearly level and rather dry area lying between the prairies of the Mississippi Valley and the Rocky Mountains. No hard and fast boundaries can be given to it in a bulletin of this kind.

We are here concerned only with the northern section of it. Roughly speaking, this is over 600 miles long, north and south, from Canada to central Kansas. From east to west it is a steady upslope from the line of 30-inch rainfall to the Rockies, with an average width of about 450 miles (fig. 3).

From the map we see that it includes the Dakotas and eastern Montana, the western portions of Nebraska and Kansas, and the northern parts of Wyoming and Colorado.



FIG. 3.—Map of the Great Plains area, showing the elevation above sea level, in feet, by means of lines following the contours at 1,000, 1,500, 2,000, 3,000, 4,000, 5,000, 6,000 feet.

In general, this section and the similar section stretching southward are spoken of as the dry plains or the semiarid plains. In the same way, the farming methods in use here are popularly called dry farming, to distinguish them from the methods used in irrigated farming in the West or in humid farming farther east.

SURFACE.

Let us look at the map (fig. 3), which shows the height in feet above sea level by means of lines, each following a different level. These are called contour lines. The larger rivers also are shown, in order to give a better idea of the slope and drainage. We note that the highest elevation (6,000 feet and over) is reached in east-central Colorado. From here the surface slopes north, east, and south, though most rapidly to the east.

The northern border of the area varies in elevation from 1,000 to 3,000 feet, while the southern edge is higher, ranging from 1,500 to 3,000 feet. The eastern boundary varies in elevation from about 1,000 feet in the Dakotas to about 1,500 feet in Kansas. Along with these wide differences in elevation are found differences in annual rainfall, length of growing season, etc., which make them of much importance to the farmer.

SOIL.

Many things besides soil are important to wheat growing in the Great Plains. Such influences as rainfall, temperature, wind, and farming methods usually are the things of greatest importance in this region. However, the kind of soil and its fertility may govern the successful growing of wheat in some places. A few definite statements about the soils of the Great Plains can be made:

1) Most of the soils in this section contain plenty of the more important plant foods, such as nitrogen, potash, phosphorus, and lime.

2) Humus, or decaying vegetable matter, is very necessary to all crops.

3) Humus gives a dark color to soils. The relative quantity of humus present can be determined, therefore, by the color of the soil in this section. Valley soils are nearly black; upland clays and loams are brown, red, or yellow; sandy soils are gray; and sands are nearly white.

4) Most of the soils in the eastern part of this northern plains region originally contained large quantities of humus. This is a result of the heavy growth of grass and other plants and their slow decay in a favorable climate.

(5) In the drier western portions of this section enough humus is not present in the soils. The size and abundance of the native vegetation decrease westward step by step as the rainfall gradually decreases.

(6) A firm seed bed and a fairly compact subsoil are desirable. Therefore, the heavier soils are best suited to the growing of wheat.

(7) The river-valley loams, clay loams, and sandy loams of the district east of the Missouri River are especially well suited to the growing of wheat.

(8) Most of the soils in this district have sufficient slope to carry good surface drainage. Where they are nearly level they should be provided with either surface drainage or subsoil drainage. If not well drained, the heavier clay soils become too tight, are hard to work, and do not give good yields.

(9) The silt loams and sandy loams west of the Missouri River are also well suited to the growing of wheat. These soils are lighter than those of the valleys in the eastern part. However, they are very fertile and productive, though often lacking in humus.

(10) Humus can be added by plowing under green-manure crops such as rye, peas, or sweet clover, or by adding well-rotted stable manure. These will rot fairly well and benefit the crop.

(11) Coarse or trashy material, such as coarse manure or straw, should not be turned under in a dry climate. It will not rot readily and, in fact, may loosen and dry out the soil too much and decrease the yields.

(12) Light soils, such as sands and sandy loams, do not hold water well. Green-manure crops or well-rotted stable manure plowed under make light soils heavier and also absorb and hold water.

(13) While sandy soils hold less moisture than heavy soils, certain plants usually can use more of the moisture stored in sandy soils than in heavier soils.

(14) Sandy soils require careful tillage to prevent their blowing. Special care is needed on the looser sands. Leaving the surface rough and working in organic matter will tend to prevent blowing. Deeper sands are best left in pasture, as the wind may cause much damage by blow-outs as soon as the vegetative covering is broken.

(15) The soils of this area sometimes have unproductive spots often due to the presence of large quantities of injurious alkali. This is a condition of the soil rather than a kind of soil. These spots, which are commonly called "gumbo," often cause much trouble.

(16) Barnyard manure applied year after year upon these spots will help to correct this condition. Means for draining them during wet years are also helpful. After they have once been subdued they are quite productive.

CLIMATE.

The climate of the northern Great Plains is marked by a low and variable annual rainfall, long cold winters, a short growing season, and rather strong wind movement.

Most of the annual moisture supply in this section comes during the four summer months of May, June, July, and August. June is the wettest of these. July and August, the months of harvest, however, are fairly wet.

Crop production throughout the entire section is governed largely by the annual rainfall.

The annual rainfall, as shown in figure 4, decreases gradually across the Plains, from 30 inches in the eastern part to 10 inches or less in the extreme western part. The heavy lines on the map show the annual rainfall in inches. The strip between any two lines represents an intermediate quantity of rain.

Much of the moisture not used by the previous crop, and also of that which falls during the autumn and early winter, is saved through the long, cold winters, during which the soil remains frozen. This, with the scanty moisture from the winter snow, is generally sufficient to start crop growth in the spring.

The later growth of the crop depends largely upon rains which occur during the growing season. The timeliness of this rainfall and the absence of hot winds and hail often govern the production of a successful crop.

The years of greatest rainfall usually have low summer temperatures and low evaporation.

Hot winds occasionally occur and cause a premature ripening and sometimes a complete drying up of the crop.

The length of the growing season is limited chiefly by the occurrence of early autumn frosts. Late spring frosts do little damage to the young wheat plants. Early fall frosts, occurring before the wheat is mature, occasionally cause a decrease in the yield and quality of the grain.

The frost-free period varies in length with the elevation above sea level, lasting for 130 days or more in the lower to 90 days in the higher altitudes.

ROTATIONS FOR SPRING WHEAT.

Rotation means simply the growing of two or more different crops on the same field in successive years instead of growing the same crop year after year. Wheat followed by corn or oats would be a rotation. Wheat followed by fallow also may be called a rotation.

One crop grown continuously, as wheat followed by wheat, is called continuous cropping or single cropping. Much of the farm land in

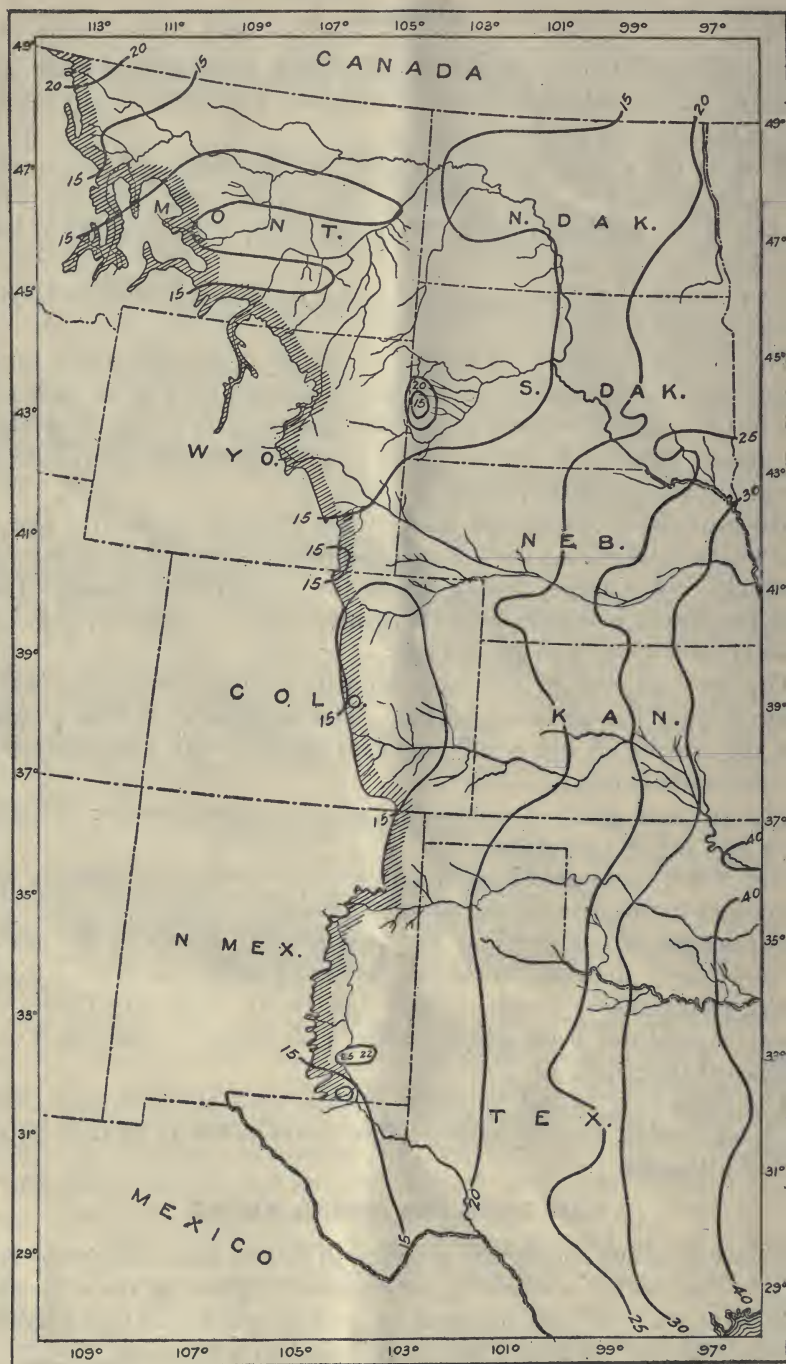


FIG. 4.—Map of the Great Plains area, showing the average yearly rainfall, in inches means of lines running through places having about the same rainfall.

The northern Great Plains area has been continuously cropped to wheat.

Farm crops become more diversified, and systems of crop rotation are started gradually as communities become older and the farms better equipped. The wheat acreage in such a community may be reduced, and yet the total production may remain the same or actually increase because of better yields from rotations than from continuous cropping. Even in the newer communities there are many advantages to be gained from having good rotation systems.

REASONS FOR ROTATING CROPS.

There are many reasons for rotating crops. Some are more important in one section, some in another. Among them may be mentioned the following:

- (1) Rotation increases the total crop yield.
- (2) It distributes the risk of crop failure, since conditions injurious to one crop frequently do not affect other crops.
- (3) It gives a better distribution of farm labor throughout the year.
- (4) It allows the keeping of more live stock, which favors a better use of farm crops and furnishes farm manure.
- (5) It allows the use of green-manure crops and the satisfactory application of farm manures, thus maintaining the fertility of the soil.
- (6) It insures a better control of weeds, injurious insects, and fungous diseases of crops.
- (7) It uses soil moisture more completely, as different crops use water differently.

EXAMPLES OF ROTATIONS.

Many problems must be solved in planning rotations for the northern Plains in which spring wheat shall be the money crop. Combining grain growing with stock raising is the best possible basis for profitable rotations and high wheat yields. It is now freely admitted that growing wheat continuously on the same land is not profitable in the long run.

In the eastern and more humid part of the northern Plains the increase of fungous diseases and weed pests is making continuous wheat cropping unprofitable. A cultivated crop is necessary in the rotation to hold the weeds in check.

For stock feeding, alfalfa and red clover can be grown quite generally in this section. Here such a rotation as (1) wheat, (2) oats (or barley), (3) clover, and (4) corn can be used with profit on combined grain and stock farms. Wheat and barley are hard to separate in mixtures, and where they volunteer freely one should not follow the other in rotation.

In the western districts of the northern Plains, where the saving of moisture is important, the cultivated crop is still more needed.

In the drier parts of western South Dakota the agricultural experiment station of that State recommends rotations containing small grains, Manchurian kaoliang, and alfalfa. The kaoliang is an early grain sorghum, taking the place of corn, which is less profitable there. About half the alfalfa should be drilled in wide-spaced rows and cultivated for seed.

Farther north; in North Dakota and Montana, corn may be grown for fodder or silage, while the cooler nights prevent the use of kaoliang. A simple rotation is (1) corn, (2) wheat, (3) oats. Where necessary, potatoes may be the cultivated crop.

Land which has borne a cultivated crop, such as corn, kaoliang, or potatoes, can be prepared for small grain much more cheaply than can stubble land.

In the driest parts it may be necessary to alternate wheat and summer fallow or to fallow the land at least every third season. Green manure crops, such as winter rye or sweet clover, may be substituted for the fallow. They should be plowed under early in the season and the surface cultivated afterwards to hasten rotting and save moisture.

SUMMER FALLOW IN THE ROTATION.

Summer fallowing land for wheat every second or third year is sometimes practiced in the drier portions of the Great Plains and especially in the winter-wheat section. Summer fallow in the rotation system reduces the danger of complete failure by drought and in some cases has increased the average annual yield.

In fallowing every second year the expense of keeping a fallow clean from the fall of one year until the spring of the second year after is usually greater than any profit from increased yield. Since only one crop is grown in two years, the average yield for two years is only one-half the actual yield of the one year.

A fallow maintained through the 18-month period mentioned requires one and sometimes two plowings and several workings with the disk and harrow to keep the land free from weeds. To save on spring working, spring plowing usually is preferable to fall plowing for fallow.

In the eastern and more humid parts of the spring-wheat section a profitable crop can be grown each year at the cost of one plowing, disking, and a harrowing.

One year of fallow in a rotation of three or more years usually will be more profitable than alternate cropping and fallowing.

Corn or other cultivated crops can be grown in place of the fallow where it is necessary to save moisture every other year for

heat crop. The following wheat crop will be nearly as large after cultivated crop as after a fallow.

The expense of growing this cultivated crop will be little or no greater than that required to keep the fallow clean. If the resulting crop matures, it will be largely profit. If not, there will be little loss.

Fallowing should not be done generally where a cultivated crop can be grown and used with profit. An occasional fallowing, however, will greatly reduce the growth of weeds and help to improve the physical and chemical condition of the soil.

PREPARING THE SEED BED.

Plowing in some form is the necessary first operation upon which agriculture has depended from the beginning. To the new settler, whose land is still in native grass, success or failure frequently depends on how he prepares his land for his first crop.

Remember that sod land in the semiarid regions should be broken deeper than that in the more humid districts. The early settlers in the Red River Valley and other fairly humid districts of the Plains found it best to break the sod land 3 inches deep in May or June and backset 5 or 6 inches deep in September or October.

The pioneers who settled later in the drier portions of the Plains found the land too dry in the fall to backset the sod and turn under the extra 2 or 3 inches of soil. Their experience shows that the sod should be broken 5 or 6 inches in depth when the grass is growing most rapidly, usually in May or June.

The sod should be turned evenly, bottom side up. It requires a sharp plow and skillful handling to strike a straight and uniform furrow.

It is best not to crop this land to wheat or any other small grain the first year. If not sown to flax, it should be worked down with a disk and harrow after the heavier rains of the summer and fall. Disking and harrowing again in the spring will make a well-prepared seed bed for wheat.

A firm seed bed with about 3 inches of fairly fine moist mulch is the best preparation for wheat.

When spring wheat is to follow a crop of wheat, oats, or barley, prepare the seed bed in the fall. Plow as quickly as possible after the former crop has been removed from the land. This holds the moisture remaining in the subsoil, stores the fall rains, and liberates nitrogen. This is of most importance in the eastern and more humid portion of the northern Plains area.

Farther west, in the drier districts, little or no moisture remains in the soil after a crop is mature. Leaving the stubble standing to catch

snow and then plowing in the spring often gives the best results under these conditions.

Plow early in the spring when fall plowing is not possible where spring plowing is best.

Plowing from 5 to 8 inches in depth has been more profitable shallower or deeper plowing.

Work down the land with a disk or harrow immediately after plowing. This prevents a rapid drying out of the newly turned soil and saves the moisture remaining below the furrow slice.

Light soils which are easily blown should not be worked too much. Furrowing them with a lister instead of plowing will largely prevent the drifting of the soil during the winter. The furrows should be leveled in the spring by disking and harrowing immediately before drilling the wheat.

Disk and harrow corn or potato ground thoroughly in the spring to prepare it for wheat.

Pack light soils, or soils loosened by plowing in trash or straw manure, with the disk or subsurface packer. Weight the disk light and set the disks straight.

WHAT IS GOOD SEED?

CHANGING SEED.

Use home-grown wheat for seed wherever possible. The common belief that seed "runs out" after a few years is not founded on fact.

The quality of seed often varies with the nature of the season. Seed of an adapted crop grown continuously in one section should not only maintain its quality year by year, but should really improve in adaptation to local conditions.

When it is necessary to get new seed it should be obtained in the community if possible. Change seed only for the purpose of getting a better variety of known value.

CLEAN SEED.

Clean and grade the seed by the use of the fanning mill, thus removing all weed seeds, trash, and broken or shrunken grains before planting. In this way the yield and quality of the crop can be better maintained.

TREATMENT FOR SMUT.

Treat the wheat seed with formalin to destroy bunt or stink smut. The method is described in Farmers' Bulletin 507, entitled "The Smuts of Wheat, Oats, Barley, and Corn." If this treatment is properly applied it will effectually prevent this smut of wheat.

After the seed is treated it will become infected again if placed in smutty bags, bins, or drills. These should all be treated unless they are known to be free from smut spores.

sow the seed within a few days after treating, as the germinating power sometimes weakens after treatment.

Loose smut, which is less common than bunt, is more difficult to control. However, it can be destroyed by the hot-water treatment, which is described also in Farmers' Bulletin 507.

The spores of the loose smut infect the young seed at the time of sowing and at no other time. Therefore, if the seed used is from a field in which and near which no smutted heads grew it will be free from this smut.

GERMINATION TESTS.

Sound, mature wheat usually germinates well. If the seed is old, unclean, or thought to have been weakened in any way, a germination test should be made. This can easily be done by counting out two or three lots of 100 kernels each and placing them between moist blotters or in sand. Keep them moist for several days, at about the temperature at which bread rises best. Only those seeds which produce strong sprouts should be counted.

Germination will always be better in blotters or sand than in the open under field conditions. Poor seed should not be sown. Seed known to be somewhat weak in vitality should be sown at a heavier rate than that ordinarily used.

SOWING THE SEED.

METHOD OF SOWING.

A modern grain drill should be used for sowing wheat. The shoe drill, the single-disk drill, and the double-disk drill are about equally well suited for seeding in a well-prepared soil. In the drier soils the double-disk drill requires less power to place the seed at a depth where moisture is present than do the other drills.

All drills should be provided with covering chains or press wheels to insure the covering of the seed. The press wheels firm the soil closely about the seed and are most valuable in sowing spring wheat in the lighter soils. The drill rows should be from 6 to 8 inches apart.

TIME OF SOWING.

Spring wheat should be sown early. On fall plowing it is usually better to sow the wheat as soon as the land can be put in good tilth than to wait until the frost is out of it.

On very weedy land postpone the seeding and kill the weeds. When the weed seeds have germinated, destroy the young weeds with a disk and harrow. The delay in seeding will be largely equalized by the more rapid growth of the wheat on land so worked. The soil warmed by the working and becomes warm more rapidly.

The best time for sowing wheat can not be given exactly for all of the section being considered. In general, sow early.

Seeding may be continued with but little risk up to the second week in May when necessary. A decreased yield will usually result from the later sowings.

RATE OF SOWING.

The quantity of seed that should be sown to the acre in the northern Great Plains area will vary with the amount of moisture present in the soil, the size of the kernel of the variety used, the condition of the seed bed, and the date of seeding.

Under ordinary conditions 4 pecks to the acre are best. In the eastern part, where the annual rainfall is high and the soil heavy, rich, warm, and well drained, 5 or 6 pecks will give better results.

In the drier and lighter soils of the western portion 3 pecks to the acre are sufficient.

Durum wheat has larger kernels and should be sown, as a rule, at a rate 1 peck heavier than common wheat under the same conditions.

On a poorly prepared seed bed or when the seeding is late, increase the rate of seeding 1 or 2 pecks over the ordinary rate.

DEPTH OF SOWING.

Sow spring wheat about 2 or 3 inches deep. Deeper than 3 inches is advised only in loose, dry soils, where it is necessary to get the seed down to moist soil. On heavy soils, where a good supply of moisture is present, 1 to 2 inches is deep enough.

CULTIVATION OF THE GROWING CROP.

A light cultivation at the time the young plants are from 4 to 6 inches high is sometimes worth while. The spring-tooth weeder is best for breaking the crust and killing weeds and is less injurious to the young plants than the spike-tooth harrow.

On heavy soils cultivate the crop in dry seasons. Do not cultivate on light soils and in years when there is enough rain for the growing wheat.

HARVESTING THE CROP.

CUTTING.

Wheat that is allowed to become mature before cutting makes the best flour. Where the acreage is small, cutting should be delayed until the kernels are well hardened.

Where the acreage to be harvested is large, cutting may begin before the grains are entirely hardened but after the straw has lost nearly all of its green color. If the crop becomes overripe, a loss in quantity from shelling may result.

Durum wheat usually looks riper than it really is. Even when very ripe it can be left standing longer than common wheat, as it does not shatter.

The greater part of the spring-wheat crop of the northern Great Plains area is cut with a binder. The condition of the bundles and their convenient handling depend largely on the adjustments of the header.

The header is used to some extent in western Nebraska and quite commonly in the James River valley of South Dakota. It is of most value where little or no rainfall occurs during the harvest season.

SHOCKING.

Wheat cut with a binder should be shocked in the field immediately. The shocks should be placed in rows, so that they can be handled later with the greatest convenience. The quality of the threshed grain depends greatly on the care used in shocking.

The shock should be started by taking a bundle in each hand and, with a single swing, jamming the butts firmly into the stubble, side by side, a few inches apart, the heads leaning against each other to prevent falling. The next two are placed against the edges of the first pair. From 6 to 8 or 10 more bundles can then be placed firmly about these until a round shock of the proper size is formed.

In the eastern, more humid and less windy districts it is well to cover the shocks to protect them from rain and birds. Make the covering by breaking down the straw at the band toward both the heads and the butts of two good bundles. These should be placed firmly on top of the standing bundles.

STACKING.

Only about one-fourth of the wheat in this hard spring-wheat section is stacked under present conditions. Thrashing directly from the shock is more commonly practiced, as the total cost usually is somewhat less.

Stacking gives greater protection, however, results in a better quality of wheat, and allows more economical thrashing. Early fall threshing is made possible by the removal of the shocks from the fields. This is usually very desirable and often will pay for the extra expense of stacking.

Well-stacked grain can be allowed to remain for weeks or months before thrashing, without damage.

Stacking should be done as soon as the grain is well cured in the shock, usually after 10 to 20 days. Four stacks are commonly built, in pairs 6 feet apart, to form a setting. The stacks are round and usually 10 feet in diameter at the base.

First, build a large, round shock or stook, about 8 feet in diameter; then place two layers of bundles, one directly on top of the other,

with heads resting against the shock, and the butts forming 10-foot circular base. The next row is laid with the butts extending just past the bands of the outer row, like shingles, and so on, lapping the rows a little more as the center is approached; then begin again at the outside.

Shocked bundles have a slanting butt. Lay the successive layers with the long edge of the butt on top and projecting beyond the layer beneath. Increase the diameter in this way until a height of 7 or 8 feet is reached. This forms the bulge.

Always keep the middle high and firmly tramped. Do not tramp the outer layer at all. If possible, have loads pitched from different sides of the stack to obtain more even tramping.

From the bulge the stack should taper slowly to a point. This is done by laying the bundles now with the short side of the slanting butt uppermost, gradually decreasing the diameter.

Keep the middle high and well tramped—so high that the beginner will fear that the outer layers will slide off. Sometimes they do, but that is better than having rain water soak in.

At the peak, which should be 20 to 24 feet from the ground, the bundles will overlap, and the cap sheaf should be securely fastened by driving a 6-foot stake into the top of the stack. Stacks well made should shed water perfectly.

THRASHING.

When thrashing can be done early, the most economical method is to thrash directly from the shock. Thrash when the grain is damp, either before or after it has gone through the sweat. If the grain is too dry, it will crack badly in thrashing.

Wheat thrashed before sweating in the shock will go through the sweat in the bins, giving the grain a darker and richer color. Corn that is thrashed when damp will sweat too much and become hot in the bin burnt. When grain is stacked it should be allowed to go through the sweat before thrashing.

Community thrashing is desirable where the farms are not large. The individual farmer will get his thrashing done more rapidly and economically where a group of farmers can own and operate a thrashing outfit together.

See that the separator is well cleaned before the thrashing is started, in order to prevent the mixture of grain and the scattering of weed seed from the neighboring farms.

Watch carefully the working of the machine to see that the grain is entirely removed from the straw and that the chaff is blown off.

Stack the straw, use it as feed or bedding for live stock, and convert it into manure.



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Contribution from the Bureau of Entomology, L. O. Howard, Chief.

HOUSE FLIES.

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INTRODUCTION.

There are several species of flies which are commonly found in
houses, although but one of these should properly be called the
house fly. This fly, *Musca domestica* L. (fig. 1), which is found in



FIG. 1.—The common house fly (*Musca domestica*): Puparium at left; adult next;
larva and enlarged parts at right. All enlarged. (Author's illustration.)

Every part of the world, is a medium-sized grayish fly; with
mouth parts spread out at the tip for sucking up liquid substances.
On account of the conformation of its mouth parts, the house fly can
bite, yet no impression is stronger in the minds of most people
than that this insect does occasionally bite. This impression is due

NOTE.—This bulletin supersedes Farmers' Bulletin No. 459. It will be of interest
everywhere breeding places for flies are found.

to the frequent occurrence in houses of another fly (*Stomoxys citrans* L.) (fig. 2), which is called the stable fly, and which, very closely resembling the house fly (so closely, in fact, as to deceive one but an entomologist), differs from it in the important partic-



FIG. 2.—The stable fly or biting house fly (*Stomoxys calcitrans*): Adult, larva, puparium, and details. All enlarged. (Author's illustration.)

ular, that its mouth parts are formed for piercing the skin. It is perhaps second in point of abundance to the house fly in most portions of the Northeastern States. It breeds in horse manure, cow manure, and in warm, decaying vegetation, like old straw and grass heaps.

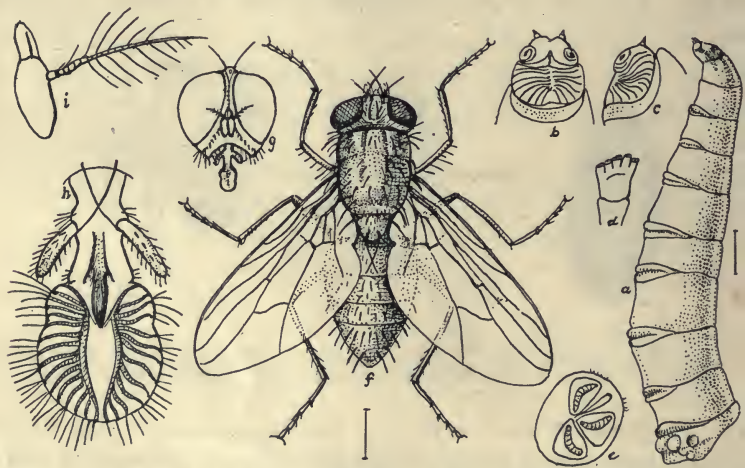


FIG. 3.—A stable fly (*Muscina stabulans*): Adult, larva, and details. All enlarged. (Author's illustration.)

A third species, commonly called the cluster fly (*Pollenia ruficornis* Fab.), is a very frequent visitant of houses, particularly in the spring and fall. This fly is somewhat larger than the house fly, with a smooth, dark-colored abdomen and a sprinkling of yellowish hairs.

is not so active as the house fly and, particularly in the fall, is very sluggish. At such times it may be picked up readily, and is very subject to the attacks of a fungous disease which causes it to die upon window panes, surrounded by whitish efflorescence. Occasionally this fly occurs in houses in such numbers as to cause great annoyance, but such occurrences are comparatively rare. It is said in its earlier stages to be parasitic on certain angleworms.

A fourth species is another stable fly known as *Muscina stabulans* Ill. (fig. 3), a form which almost exactly resembles the house fly in general appearance, and which does bite, as does the biting stable fly. It breeds in decaying vegetable matter and in excrement.

Several species of metallic greenish or bluish flies are also occasionally found in houses, the most abundant of which is the so-called bluebottle fly (*Calliphora erythrocephala* Meig.). This insect is also called the blow fly, or meat fly, and breeds in decaying animal material. A smaller species, which may be called the small bluebottle fly, is *Phormia terraenovae* Desv. (fig. 4), and a third, which is green or blue in color and a trifle smaller than the large bluebottle fly, is *Lucilia caesar* L. (fig. 5).



FIG. 5.—The green-bottle fly (*Lucilia caesar*): Adult, enlarged. (Author's illustration.)

It has a more pointed body and conical shape. The male, which is much commoner than the female, has large pale patches at the base of the abdomen, which are translucent when the fly is seen on the window pane. It is this species that is largely responsible for the prevalent idea that flies grow after gaining wings. Most people think that these little fannias are the young of the larger flies, which,



FIG. 4.—One of the blue-bottle flies (*Phormia terraenovae*): Adult, enlarged. (Author's illustration.)

There is still another species, smaller than any of those so far mentioned, which is known to entomologists as (*Homalomyia*) *Fannia canicularis* L., sometimes called the small house fly. A related species, *F. brevis* Rond., is shown in figure 6. *F. canicularis* is distinguished from the ordinary house fly by its

of course, is distinctly not the case. They breed in decaying vegetable material, in excreta of animals, and in dead insects.

Still another fly—and this one is still smaller—is a jet-black species known as the window fly (*Scenopinus fenestralis* L.), which



FIG. 6.—The little house fly (*Homalomyia brevis*): Female at left; male next, with enlarged antenna; larva at right. All enlarged. (Author's illustration.)

in fact has become more abundant of later years. Its larva is a very slender, almost threadlike creature and is found in cracks of floor in buildings, where it feeds on other small insects.

In the autumn, when fruit appears on the sideboard, many specimens of a small fruit fly (*Drosophila ampelophila* Loew) (fig. 7) make their appearance, attracted by the odor of overripe fruit.

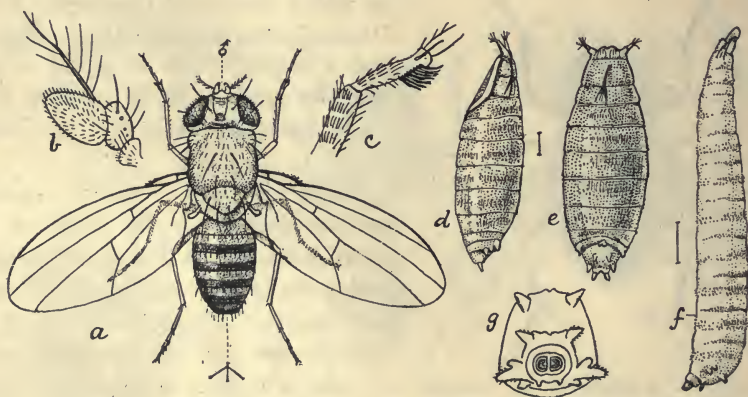


FIG. 7.—The fruit fly (*Drosophila ampelophila*): a, Adult; b, antenna of same; c, basitibia and first tarsal joint of same; d, puparium, side view; e, puparium from above; f, full-grown larva; g, anal spiracles of same. All enlarged. (Author's illustration.)

A small slender fly is not infrequently seen in houses, especially upon windowpanes. This is *Sepsis violacea* Meig., shown enlarged in figure 8.

All of these species, however, are greatly dwarfed in numbers by the common house fly. In 1900 the senior author made collections

the flies in dining rooms in different parts of the country, and of a total of 23,087 flies 22,808 were *Musca domestica*—that is, 98 per cent of the whole number captured. The remainder, consisting of 1.2 per cent of the whole, comprised various species, including those mentioned above.

LIFE HISTORY OF THE TRUE HOUSE FLY.

Musca domestica commonly lays its eggs (figs. 9, 10) upon horse manure. This substance seems to be its favorite larval food. It will also breed in human excrement, and from this habit it becomes very

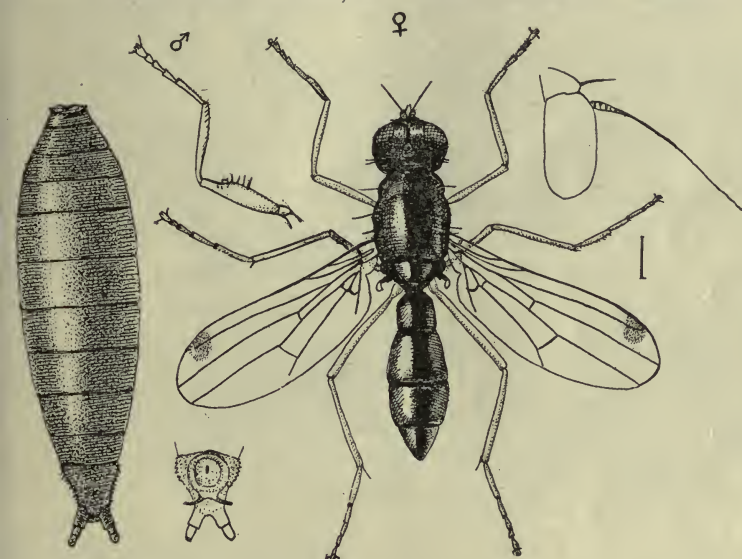


FIG. 8.—The dung fly (*Sepsis violacea*): Adult, puparium, and details. All enlarged. (Author's illustration.)

dangerous to the health of human beings, carrying as it does the germs of intestinal diseases, such as typhoid fever and cholera, from excreta to food supplies. It has also been found to breed freely in hog manure and to some extent in cow and chicken manure. Indeed, it will lay its eggs on a great variety of decaying vegetable and animal material, but of the flies that infest dwelling houses, both in cities and on farms, a vast proportion come from horse manure.

It often happens, however, that this fly is very abundant in localities where there is little or no horse manure, and in such cases it will be found breeding in other manure or in slops or fermenting vegetable material, such as spent hops, bran, ensilage, or rotting potatoes. Accumulations of organic material on the dumping grounds of towns and cities often produce flies in great numbers.

The number of eggs laid by an individual fly at one time is undoubtedly large, probably averaging about 120, and as a single female will lay at least two and possibly four such batches, the enormous numbers in which the insects occur is thus plainly accounted for, especially when the abundance and universal occurrence of appropriate larval food is considered. The eggs are deposited below the surface in the cracks and interstices of the manure, several females usually depositing in one spot, so that the eggs are commonly found in large clusters in selected places near the top of the pile.

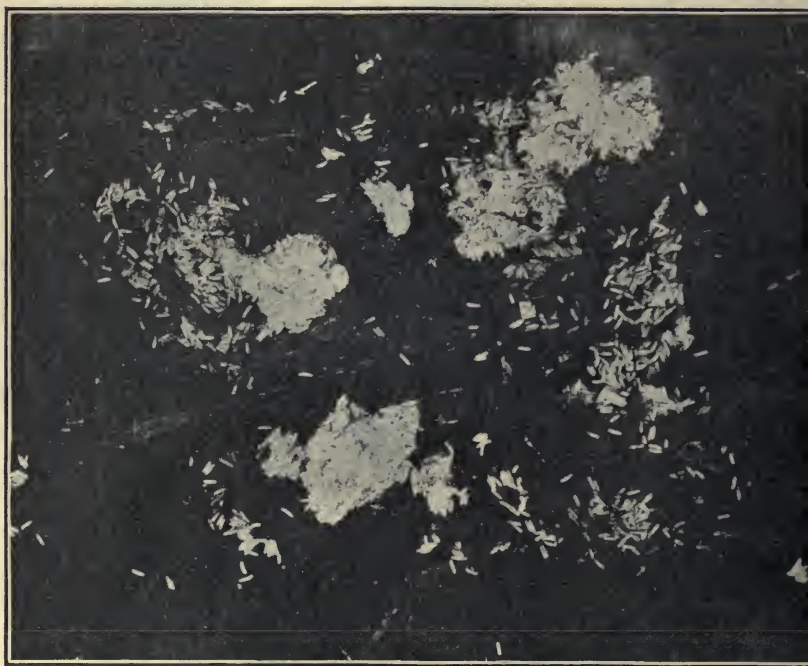


FIG. 9.—Eggs of the house fly. About natural size. (From Newstead.)

where a high degree of heat is maintained by the fermentation below. The eggs usually hatch in less than 24 hours. Under the most favorable conditions of temperature and moisture the egg state may last hardly more than eight hours. The maggots which issue from the eggs are very small and transparent. They grow rapidly and in the course of their development molt twice. There are thus three distinct larval stages, the duration of which is about as follows: (1) From hatching of the larva to first molt, one day; (2) first to second molt, one day; (3) second molt to pupation, two to three days, thus making the total length of the larval stage four to five days. This period may be greatly prolonged by low temperature or by dryness or scarcity of the larval food. As the larvæ (fig. 11)

in full size they gradually assume a creamy white color. Just before pupation they become very restless and migrate from their resting ground in search of a favorable place in which to pass the pupal stage. They will often congregate at the edges of manure piles or the ground or burrow into the soil beneath, or they may crawl considerable distances away from the pile to pupate in the ground or in loose material under the edges of stones, boards, etc.

The pupæ (fig. 12), or "sleepers," are more or less barrel shaped and dark brown in color. In midsummer this stage lasts from three to ten days, four to five days being the usual duration. The pupal stage is easily affected by temperature changes and may be prolonged



FIG. 10.—Eggs of the house fly. Highly magnified. (From Newstead.)

ing hibernation for as long as four or five months. Numerous spring experiments in various parts of the country have shown that the shortest time between the deposition of eggs and the emergence of the adult fly is eight days, and 10 and 12 day records were very common.

The adult fly, upon emerging from the puparium, works its way upward through the soil or manure and upon reaching the air it crawls about while its wings expand and the body hardens and assumes its normal coloration. In a very few days the female is ready to deposit eggs. In recent experiments at Dallas, Tex., at New Orleans, La., and at Arlington, Va., it has been found that the

time between the emergence of the adults and the first deposition of eggs is considerably shorter than was previously thought to be the case. Only three or four days are necessary in midsummer for the female to reach sexual maturity. As in the case of other periods in its life history, so the preoviposition period is considerably prolonged by the lower temperatures of spring and autumn. In midsummer, with a developmental period of from eight to ten days from egg to adult, and a preoviposition period of from three to four days, there would be a new generation started every 11 to 14 days. There is thus abundance of time in the climate of Washington for the development of 10 to 12 generations every summer.

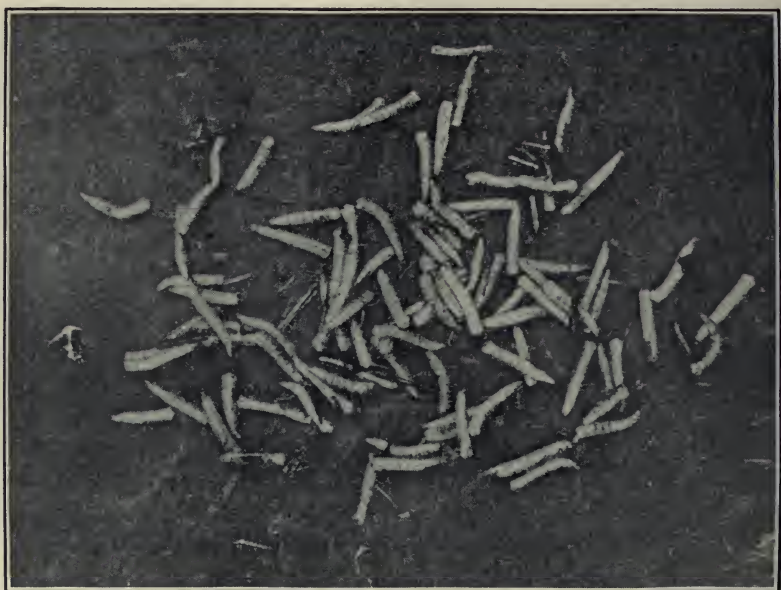


FIG. 11.—Larvæ, or maggots, of the house fly. About natural size. (From Newstead.)

The hibernation of the house fly is a subject to which considerable attention has recently been given, and many new points of practical importance have come to light. The prevailing idea that the house fly passes the winter as an adult, hiding in the cracks and crevices of buildings and in straw stacks, etc., has never been proved experimentally. Messrs. Bishopp, Dove, and Parman made attempts to keep adults in large cages through the winter of 1913-14 at Dallas, Texas. In one experiment in which the cage was kept in a building which was heated during cold periods some flies remained alive for several days. In some experiments carried out by the junior author at New Orleans during the same winter all the flies died within a period of 30 days, most of them as a result of the attack of a parasitic

agus. Careful experiments conducted at the experiment farm at Arlington, Va., during the winter of 1914-15 showed that flies kept in unheated buildings were killed during the first really cold nights of the winter. Those kept in one of the greenhouses behaved just as they would during the summer at similar temperatures. At temperatures of 65° to 75° F. very few lived longer than 35 to 40 days. The best conditions were found in one of the large stables which was slightly heated, the temperature ranging from 32° to 50° F. Some



FIG. 12.—Pupæ of the house fly. About natural size. (From Newstead.)

flies were kept alive here for a period of 70 days, a long period, but sufficient to carry them through the winter.

Regular collections of flies were made at the Arlington farm during the winter of 1914-15. No living adult house flies were found after the middle of January until April 30, while *Pollenia*, which does not hibernate in the adult state, could be found in buildings almost any time during the winter, and on warm days they were found outside.

On the other hand, there are on record some experiments and observations which indicate that the usual manner in which the house fly passes the winter is in the pupal stage. Bishopp, Dove, and Parson succeeded in two instances in keeping the species through the winter in the larval and pupal stages. Three barrels of heavily in-

fested manure were covered with a large screen cage on November 26, 1913. No adults emerged after December 27 until April 16, 1914, and others on May 26, at which time observations were discontinued. This showed that the house fly lived in the larval and pupal stages for periods of from five to six months. In another case they were kept alive in the immature stages from December 16, 1913, to April 4, 1914. This was at Dallas, Tex.

CARRIAGE OF DISEASE.

The body of the house fly is thickly covered with hairs and bristles of varying lengths, and this is especially true of the legs. Thus when it crawls over infected material it readily becomes loaded with germs, and subsequent visits to human foods result in their contamination. Even more dangerous than the transference of germs on the legs and body of the fly is the fact that bacteria are found in great numbers and live longer in the alimentary canal. These germs are voided, not only in the excrement of the fly, but also in small droplets of regurgitated matter which have been called "vomit spots." When we realize that flies frequent and feed upon the most filthy substances (it may be the excreta of typhoid or dysentery patients or the discharges of one suffering from tuberculosis), and that they may subsequently contaminate human foods with their feet or their excrement or vomit spots, the necessity and importance of house-fly control is clear.

In army camps, in mining camps, and in great public works, bringing together large numbers of men for a longer or shorter time, there is seldom the proper care of excreta, and the carriage of typhoid germs from the latrines and privies to food by flies is common and often results in epidemics of typhoid fever.

And such carriage of typhoid is by no means confined to great temporary camps. In farmhouses in small communities, and even in badly cared for portions of large cities, typhoid germs are carried from excrement to food by flies, and the proper supervision and treatment of the breeding places of the house fly become most important elements in the prevention of typhoid.

In the same way other intestinal germ diseases are carried by flies. Asiatic cholera, dysentery, and infantile diarrhea are all so carried. Nor are the disease-bearing possibilities of the house fly limited to intestinal germ diseases. There is strong circumstantial evidence that tuberculosis, anthrax, yaws, ophthalmia, smallpox, tropical sore, and parasitic worms may be and are so carried. Actual laboratory proof exists in the case of a number of these diseases, and where lacking is replaced by circumstantial evidence amounting almost to certainty.

NATURAL ENEMIES.

The house fly has a number of natural enemies. The common house centipede (fig. 13) destroys it in considerable numbers; there is a small reddish mite which frequently covers its body and gradually destroys it; it is subject to the attacks of hymenopterous parasites in its larval and pupal condition; and it is destroyed by predatory beetles at the same time.

The most effective enemy of the house fly, however, is a fungous disease known as *Empusa muscae*, which carries off flies in large numbers, particularly toward the close of the season. The epidemic cases in December, and, although many thousands are killed by it, the remarkable rapidity of development in the early summer months soon more than replaces the numbers thus destroyed.

PREVENTIVE AND CONTROL MEASURES.

THE USE OF SCREENS.

A careful screening of windows and doors during the summer months, with the supplementary use of sticky fly papers, is a preventive measure against house flies known to everyone. As regards screening it is only necessary here to emphasize the importance of keeping food supplies screened or otherwise covered so that flies can have no access to them. This applies not only to homes, but also to stores, restaurants, milk shops, and the like. Screening will, of course, have no effect in decreasing the number of flies, but at least it has the virtue of lessening the danger of contamination of food.

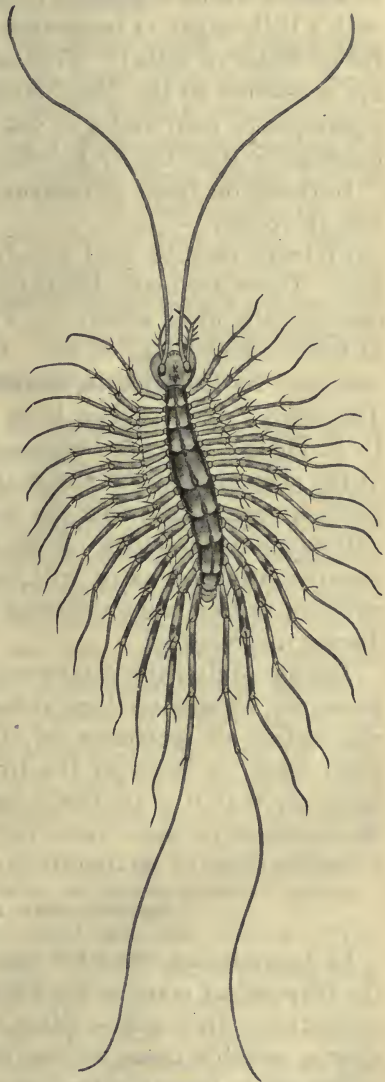


FIG. 13.—The house centipede (*Scutigera forceps*): Adult, natural size. (After Marlatt.)

FLY PAPERS, POISONS, AND TRAPS.

In the effort to destroy flies that have gained access to houses the use of sticky fly papers is very common. Another way is to expose in shallow dishes a mixture of formalin and milk or water, sweetened with a little sugar (1 teaspoonful of commercial formalin to 1 teacupful of water or milk). This is most effective when no other liquids are accessible to the flies. Formalin diluted in this manner is not poisonous to man and will not injure fabrics. In this respect it is much safer than the fly poisons containing arsenic.

Burning of fresh pyrethrum powder is also effective in killing flies in rooms.

Flytraps may be used to advantage in decreasing the number of flies. There are many kinds on the market, and as a rule the larger ones are the more effective. These should be placed on the outside of houses, stores, stables, etc. Bananas, sugar and vinegar, milk, and beer will be found to be attractive baits under most circumstances. The use of flytraps has been enthusiastically advocated by Prof. C. F. Hodge, not only because of the immediate results, but because of the chances that the flies may be caught before they lay their first batch of eggs, and thus the possible number of future generations will be greatly reduced. From what was said above in regard to the preoviposition period it will be apparent that flytraps will be more effective in this respect during the spring and autumn months than during midsummer.

The use of fly papers, poisons, and traps are at best only temporary measures. The most logical method of abating the nuisance is the elimination or treatment of all breeding places. It would appear from what we know of the life history and habits of the common house fly that it is perfectly feasible for cities and towns to reduce the numbers of these annoying and dangerous insects so greatly as to render them of comparatively slight account.

CONSTRUCTION AND CARE OF STABLES.

In formulating rules for the construction and care of stables and the disposal of manure the following points must be taken into consideration. In the first place, the ground of soil-floor stables must offer a suitable place for the development of fly larvæ. The larvæ will migrate from the manure to the soil and continue their growth in the moist ground. This takes place to some extent even when the manure is removed from the stables every day. Even wooden floors are not entirely satisfactory unless they are perfectly water-tight, since larvæ will crawl through the cracks and continue their development in the moist ground below. Water-tight floors of concrete or masonry are therefore desirable.

Flies have been found to breed in surprising numbers in small accumulations of material in the corners of feed troughs and mangers, and it is important that such places be kept clean.

FLY-TIGHT MANURE PITS OR BINS.

The Bureau of Entomology has for some years advised that manure from horse stables be kept in fly-tight pits or bins. Such bins can be built in or attached to the stable so that manure can be easily thrown in at the time of cleaning and so constructed that the manure can be readily removed. The essential point is that flies be prevented from reaching the manure, and for this reason the pit or bin must be tightly constructed and the lid kept closed except when the manure is being thrown in or removed. There is no doubt as to the effectiveness of this method when the necessary precautions are taken, especially if the manure is removed at frequent intervals.

FREQUENCY WITH WHICH MANURE SHOULD BE REMOVED.

Another point must be considered in deciding the question as to how often the manure should be removed. In this connection it should be borne in mind that when the larvæ have finished feeding, they will often leave the manure and pupate in the ground below or crawl some distance away to pupate in débris under boards or planks and the like. Hence the manure should be removed before the larvæ reach the migratory stage; that is to say, removal is necessary every three days, and certainly not less frequently than twice a week during the summer months. A series of orders issued in 1906 by the Health Department of the District of Columbia, on the authority of the Commissioners of the District, covers most of these points, and these orders, which may well serve as a model to other communities desiring to undertake similar measures, may be briefly condensed as follows:

HEALTH OFFICE REGULATIONS FOR CONTROL OF HOUSE FLIES IN CITIES.

All stalls in which animals are kept shall have the surface of the ground covered with a water-tight floor. Every person occupying a building where domestic animals are kept shall maintain in connection therewith a bin or pit for the reception of manure and, pending the removal from the premises of the manure from the animal or animals, shall place such manure in said bin or pit. This bin shall be so constructed as to exclude rain water and shall in other respects be water-tight, except as it may be connected with a public sewer. It shall be provided with a suitable cover and constructed so as to prevent the ingress and egress of flies. No person owning a stable shall keep any manure or permit any manure to be kept in or upon any portion of the premises other than the bin

or pit described, nor shall he allow any such bin or pit to be overfilled or needlessly uncovered. Horse manure may be kept tightly rammed into well-covered barrels for the purpose of removal in such barrels. Every person keeping manure in the more densely populated parts of the District shall cause all such manure to be removed from the premises at least twice every week between June and October 31, and at least once every week between November and May 31 of the following year. No person shall remove or transport any manure over any public highway in any of the more densely populated parts of the District except in a tight vehicle which, if not inclosed, must be effectually covered with canvas, so as to prevent the manure from being dropped. No person shall deposit manure removed from the bins or pits within any of the more densely populated parts of the District without a permit from the health officer. Any person violating any of the provisions shall, upon conviction thereof, be punished by a fine of not more than \$4 for each offense.

Not only must horse stables be cared for, but chicken yards, piggeries, and garbage receptacles as well. In cities, with better methods of disposal of garbage and with the lessening of the number of horses and horse stables consequent upon electric street railways, bicycles, and automobiles, the time may come, and before very long when window screens may be discarded.

DISPOSAL OF MANURE IN RURAL AND SUBURBAN DISTRICTS.

The control of flies in rural and suburban districts offers a much more difficult problem. Here it is out of the question to remove all manure from the premises twice a week. The problem is rather to find some method of disposal or storage which will conserve the fertilizing value of the manure and at the same time prevent all flies from breeding or destroy such as do breed there.

With this idea in mind it has been recommended that stable manure be removed every morning and hauled out at once and spread rather thinly on the fields. This procedure is advisable from the point of view of getting the maximum fertilizing value from the manure. Immediate spreading on the fields is said largely to prevent the loss of plant food which occurs when manure is allowed to stand in heaps for a long time. This method will be effective in preventing the breeding of flies only if the manure is hauled out promptly every morning and spread thinly so that it will dry, since it is unfavorable for fly development in dessicated condition. Removal every three or four days will not be sufficient. Observations have shown that if manure becomes flyblown, and the maggots attain a fairly good size before the manure is scattered on the fields, they can continue their

development and will pupate in the ground. A further objection is that during the summer months, when fly breeding is going on most actively, the agriculturist is also busy and can seldom spare the time to devote the teams to carry out such a program regularly.

CHEMICAL TREATMENT OF MANURE TO DESTROY FLY MAGGOTS.

The general practice is, therefore, to remove manure and keep it in heaps located as a rule very near the stables. How can fly breeding be prevented in such accumulations? As a result of recent investigations it is now possible to point out two methods which are practical and effective.

The first is the treatment of the manure pile with chemical substances which will kill the eggs and maggots of the house fly. The Bureau of Entomology, in cooperation with the Bureau of Chemistry and the Bureau of Plant Industry, has conducted a series of experiments during the last two years in which a large number of chemicals were applied to infested manure and observations made not only on their efficiency in killing the maggots, but also as to their effect on the chemical composition and bacterial flora of the manure. The object was to find some cheap chemical which would be effective in destroying the fly larvæ and at the same time would not reduce the fertilizing value of the manure.

TREATMENT WITH HELLEBORE.

Of the numerous substances tried, the one which seems best to fulfill these conditions is powdered hellebore. Some of the powdered hellebore in use is prepared from the roots of a plant which botanists know as *Veratrum viride*, and which is popularly known as Indian polk or itch weed. It is common in wet grounds and is of wide distribution in the United States. The European species of this plant, *Veratrum album*, however, furnishes the bulk of the supply. Hellebore contains a number of chemical compounds known as alkaloids. Alkaloids are organic substances, of which quinine, morphine, and cocaine may be mentioned as examples, which act very intensely on the animal body. For the treatment of manure a water extract of the hellebore is prepared by adding $\frac{1}{2}$ pound of the powder to every 10 gallons of water, and after stirring it is allowed to stand 24 hours. The stock mixture thus prepared is sprinkled over the manure at the rate of 10 gallons to every 8 bushels (10 cubic feet) of manure. From the result of 12 experiments with manure piles treated under natural conditions it appears that such treatment results in the destruction of from 88 to 99 per cent of the fly larvæ. Amounts of hellebore less than $\frac{1}{2}$ pound to every 8 bushels of manure are not so effective, while stronger applications will, of course, give somewhat better results.

Bacteriological studies of the treated piles proved that the bacteria were not injured nor their development retarded, and chemical analysis showed that the composition of the manure was unaltered. Furthermore, several field tests were made in growing cabbages, turnips, lettuce, potatoes, wheat, and a few other crops on plats which had been fertilized with hellebore-treated manure, with the result that there appeared no injury whatever that could be ascribed to the use of this substance. The only possible objection to the use of hellebore seems to be the possibility of poisoning farm animals, as might happen if, for example, the barrel or tank in which the stock solution was prepared were left uncovered in an accessible place. It is quite safe to say that chickens will not be injured by pecking at hellebore-treated manure. This has been tested carefully. Hellebore can be obtained both in ground and powdered form, but the powdered form gives the best results in the destruction of fly larvæ. It costs from 12 to 16 cents per pound and under normal conditions can be obtained in large lots for 10 cents or less per pound. It is estimated that the cost of treating horse manure with hellebore will be a little over 1 per cent for every 2 bushels. It will be of interest to the agriculturist to know that in applying hellebore to manure he is adding a substance which contains fully 1 per cent of nitrogen.

TREATMENT WITH POWDERED BORAX.

Another chemical found to be even more effective as a larvicide is powdered borax. This is an inorganic substance, available in commercial form in all parts of the country. It has the advantage of being comparatively nontoxic and noninflammable and is easily transported and handled. The minimum amount necessary to kill fly larvæ was found to be 0.62 pound per 8 bushels of manure, or about 1 pound per 16 cubic feet. Best results were obtained when the borax was applied in solution, or when water was sprinkled on after the borax had been scattered evenly over the pile. Borax is not only effective in killing the larvæ, but when it comes in contact with the eggs it exerts a toxic action which prevents them from hatching. When applied at the rate of 1 pound to 16 cubic feet it was found to kill about 90 per cent of the larvæ, heavier applications killing from 98 to 99 per cent.

Borax had no injurious effect on the composition of the manure. In fact, in some cases the ammonia and water-soluble nitrogen seemed to be increased; nor was there any permanent decrease in the number of bacteria. Borax-treated manure was less subject to the growth of molds and consequent firefanging. Now, although borax does not have any deleterious effect on the chemical composition of manure, yet when added to the soil with the manure it acts directly on plants.

large applications will cause considerable injury. On the other hand, certain investigators have shown that small amounts of borax have a stimulating effect. The question is, therefore, whether any injury to plants will result from the application of manure treated at the rate of 1 pound per 16 cubic feet. To answer this point numerous tests were carried out, both in the greenhouse and under field conditions, using borax-treated manure for fertilizing a number of different crops, such as wheat, potatoes, peas, beans, lettuce, and others. As far as these experiments have gone they indicate that if manure so treated is applied at a rate of not more than 15 tons per acre no injury, as a rule, will follow. However, some plants are more sensitive to the presence of borax than others, and the effects are more noticeable on some soils than on others. All crops have not been tested, nor has the cumulative effect of borax treatment been worked out. It is necessary, therefore, to repeat the warning issued in connection with a previous bulletin on this subject, that great care should be exercised in the application of borax, so that the manure will never receive more than 1 pound for every 16 cubic feet and that not more than 15 tons of manure so treated should be applied to the acre.

THE BEST SUBSTANCE FOR TREATMENT OF MANURE INTENDED FOR USE AS A FERTILIZER.

In view of the possible injury from the borax treatment as a result of carelessness in applying it, or from other unforeseen conditions, it is recommended that horse manure and other farmyard manures which are to be used as fertilizer should be treated with carbollene. Borax, on the other hand, is such a good larvicide that it can be used with advantage on the ground of soil-floor stables, in privies, on refuse piles, and on any accumulations of fermenting organic matter which are not to be used for fertilizing purposes.

Of course there are a number of other insecticides which are effective against fly larvæ. Potassium cyanid, Paris green, arsenite of soda, etc., are effective, but they are hardly to be recommended for general use because of their extremely poisonous nature. Others, like pyridine, aniline, and nitrobenzene emulsion, are rather too expensive when used in amounts necessary to kill the maggots.

MAGGOT TRAP FOR DESTRUCTION OF FLY LARVÆ FROM HORSE MANURE.

The second method of handling manure is one which does not require the application of chemicals. It is based on the fact mentioned on page 7 that the larvæ of the house fly, when about ready to pupate, show a very strong tendency to migrate. They leave the spot where they have been feeding and crawl about in search of a suitable

place for pupation. This migration takes place mostly at night, and the larvæ sometimes crawl considerable distances away from the manure pile. Now it is possible by means of a very simple arrangement called a maggot trap to destroy fully 99 per cent of all maggot breeding in a given lot of manure. A successful maggot trap which the Maryland Agricultural College constructed at the college barn last year is shown in figure 14. The trap was designed by the junior author and constructed under his supervision. The manure, instead of being thrown on the ground, is heaped carefully on a slatted platform, which stands about 1 foot high. This particular platform mea-



FIG. 14.—A maggot trap for house-fly control. View of the maggot trap, showing the concrete basin containing water in which larvæ are drowned, and the wooden platform on which manure is heaped. (From Hutchison.)

ures 10 by 20 feet. There are six 2 by 4 pieces running lengthwise 2 feet apart. Across these are nailed 1-inch strips with $\frac{1}{2}$ to 1 inch spaces between them. The wooden platform stands on a concrete floor, and a rim or wall of concrete 4 inches high surrounds the floor. The floor slopes a little toward one corner, from which a pipe leads to a small cistern near by. This pipe is plugged with a stopper of soft wood, and the concrete floor is filled with water to a depth of 1 inch in the shallowest part. The manure is then heaped on the platform each morning when it is removed from the stable. Flies will lay their eggs on the manure as usual, but the maggots, when they have finished feeding and begin to migrate, crawl out of the

ure, drop into the water below, and are drowned. Each week plug is removed from the pipe, and all the maggots are washed into the cistern. The floor is then cleaned of any solid particles by means of a long-handled stable broom or by a strong stream of water from a hose. The pipe being again plugged, the floor is again partly filled with water and the trap is ready for another week's catch. A trap of this size will hold the manure accumulating from four stalls during the period of four months, or about 20 days' accumulation from 25 horses, if the heap is well built and made at least 5 feet high.

Experience with maggot traps has brought out the following results: In the first place, the trap is more effective when the manure is kept compactly heaped and well moist. This is to be explained by the fact that the larvæ seek a comparatively dry place in which to

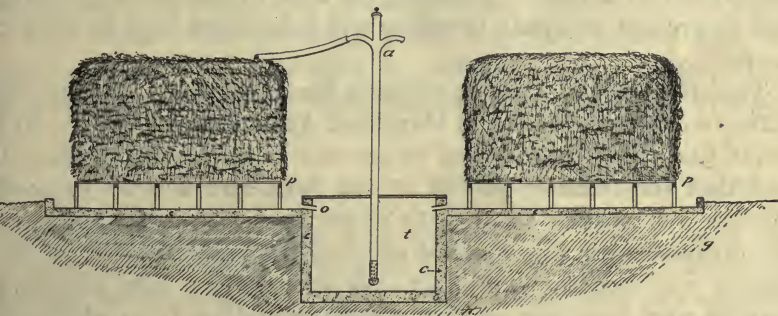


Fig. 15.—Imaginary cross section of an arrangement suggested for use where manure production is large. *a*, Pump; *c*, concrete floor and walls of cistern; *o*, outlet pipes leading from floor of maggot trap to cistern; *p*, platform maggot trap; *t*, cistern for liquid manure; *g*, ground level. (From Hutchison.)

ate, and crawl away from wet manure. A cistern should be built close to the trap, and a pump fitted so that liquids can be pumped onto the heap. (Fig. 15.) Each day, after the litter from the stable has been thrown on the heap, just enough water should be added to moisten it thoroughly without causing leaching. The ideal arrangement would be to have water-tight floors in the stalls and drains leading to the cistern. The liquid manure collecting in the cistern could be pumped on the manure heap, thus not only maintaining the moisture content necessary to insure the greatest amount of migration, but also adding to the manure the valuable constituents of the urine. It happens, too, that keeping the manure carefully heaped and watered promotes the anaerobic fermentation and tends to prevent to some degree the loss of ammonia and gaseous nitrogen. In the second place the platform should stand not less than 1 foot above the concrete floor. This is to facilitate cleaning the floor of maggots and the débris which unavoidably accumulates there. The

floor should be cleaned at least once a week, and all liquids run into the cistern, in order to prevent mosquitoes from breeding in the water in the floor of the trap. A thin film of oil can be used to prevent mosquito breeding in the cistern.

A third point of importance is that old manure is unfavorable for fly breeding. Experiments have shown that after manure has been standing on a maggot trap for eight to ten days it is practically free from maggots, and no more will appear in it. This means that a given lot of manure need remain on the maggot trap for only 10 days in order to prevent any breeding taking place in it.

The maggot trap is simple, easily constructed, and cheap. Practically the only cost is the initial one for the construction. Very little extra labor is required to operate it. Only a few minutes each day are necessary to water the manure after the stable cleanings have been added to the heap. Cleaning the floor to dispose of the maggots and to prevent mosquito breeding will take about half an hour once a week.

That the maggot trap is effective has been shown by the junior author's observations at the Maryland Agricultural College. It was found that the trap destroyed 99 per cent of the larvæ breeding there and that the number of flies at the barn and around the college kitchen was reduced from 67 to 76 per cent. That the reduction in the prevalence of flies was not equal to the percentage of larvæ destroyed was ascribed to the fact that several other piles of untreated manure were breeding out flies at near-by stables, from which places they were attracted to the barn and kitchen.

Maggot traps may be constructed in almost any size and to suit almost any conditions, and appear to be especially adapted to meet the problem of fly control under rural conditions.

TREATMENT OF MISCELLANEOUS BREEDING PLACES.

It is just as true under farm conditions as in cities that breeding places other than horse manure must be attended to. Garbage must be disposed of, hog and poultry manure must be cared for, and especially on dairy farms it is extremely important that every precaution be taken to prevent the contamination of milk by flies. Care and cleanliness, combined with some of the arrangements just described, will measureably affect the fly nuisance in neighboring buildings.

SEWAGE DISPOSAL IN RELATION TO THE PREVENTION OF FLY-BORNE DISEASE

In the consideration of these measures we have not touched upon the remedies for house flies breeding in human excrement. On account of the danger of the carriage of typhoid fever, the dropping of human excrement in the open in cities or towns, either in vacant

ots or in dark alleyways, should be made a misdemeanor, and the same care should be taken by the sanitary authorities to remove or cover up such depositions as is taken in the removal of the bodies of dead animals. For modern methods of sewage disposal adapted for farm use one should consult Department Bulletin No. 57, which may be obtained from the Superintendent of Documents for 10 cents. In the absence of modern methods of sewage disposal absolutely sanitary privies are prime necessities, whether in towns or on farms. Directions for the building and caring for such privies will be found in Farmers' Bulletin No. 463. The box privy is always a nuisance from many points of view, and is undoubtedly dangerous as a breeder of flies which may carry the germs of intestinal diseases. The dry-earth treatment of privies is unsatisfactory. No box privy should be permitted to exist unless it is thoroughly and regularly treated with some effective larvicide. Since the fecal matter in such privies is seldom used for fertilizing purposes it may well be treated liberally with borax. The powdered borax may be scattered over the exposed surface so as to whiten it. An application two or three times a week during the fly season ought to prevent all fly breeding in such matter.

WHAT COMMUNITIES CAN DO TO ELIMINATE HOUSE FLIES.

Antifly crusades have been very numerous in recent years, and some have been noteworthy both as to methods and results. However, it will not be amiss here to emphasize the importance of concerted, organized effort on the part of whole communities, not only cities, but suburban and rural neighborhoods as well. By the most painstaking care one may prevent all fly breeding on his premises, but it will avail him little if his neighbors are not equally careful. Some sort of cooperation is necessary. One of the first and most important elements in any antifly crusade is a vigorous and continued educational campaign. It has been the experience of those who have undertaken such crusades that people generally regard the fly as a somewhat harmless nuisance and that the first work of the campaign was to bring the people to a realization of the dangers from flies and the possibility of getting rid of them. In the educational campaign every possible means of publicity can be employed, including newspapers, lectures, moving pictures, posters, handbills, cartoons, instruction in schools, etc.

The antifly crusade is a matter of public interest and should be supported by the community as a whole and engineered by the health officers. But health officers can do little toward the necessary work of inspection and elimination without funds, and therefore the support of the campaign must manifest itself in increased appropriations

for public-health work. The example of York Village, Me., is one to be emulated. The appropriation for health work in that city amounts to about \$1 per capita per year—the largest per capita expenditure for public-health work of any community in the United States. Very often it is lack of funds which prevents the health officers from taking the initiative in the antityphoid crusades, and there must necessarily be much agitation and education before they can profitably take up the work. Right here lies a field for civic associations, women's clubs, boards of trade, etc., to exercise their best energy, initiative, and leadership.

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UNITED STATES DEPARTMENT OF AGRICULTURE



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Contribution from the Bureau of Plant Industry, Wm. A. Taylor, Chief.

VARIETIES OF HARD SPRING WHEAT.

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INTRODUCTION.

This paper deals with the varieties of hard spring wheat, both common and durum. What they are, how and when they came to be, and how to tell them apart are stated clearly. The particular sections and districts to which they are suited are shown.

Very few popular descriptions of wheat varieties have been available in the past. Consequently, farmers have had little chance to become acquainted with the differences between varieties.

Farmers have been urged to keep their varieties pure. In order to do this they must be able to know what a variety really looks like. They have been advised to grow only one variety in a community. It was not always were they told what variety was best and why.

It is not always easy to recognize a variety from its description. Often two varieties really different look very much alike. Sometimes the visible difference is very small. Sometimes there is no visible difference at all, although there is a real difference in yielding power.

Unfavorable weather conditions often change the appearance of a variety very much. Droughts reduce the height, bleach the colors, and shrink the kernel. Wet weather may increase the height above the average and change the color of the spike and chaff. Attacks of rust and other diseases also cause changes in appearance.

It is hoped that this bulletin may help the northern Plains farmer to know—

- (1) The differences that exist between different groups of wheat.
- (2) The real varieties that are found in each of these groups.
- (3) What varieties or group of varieties are best suited for growing in his community.

The spring-wheat crop is important in the United States. Near

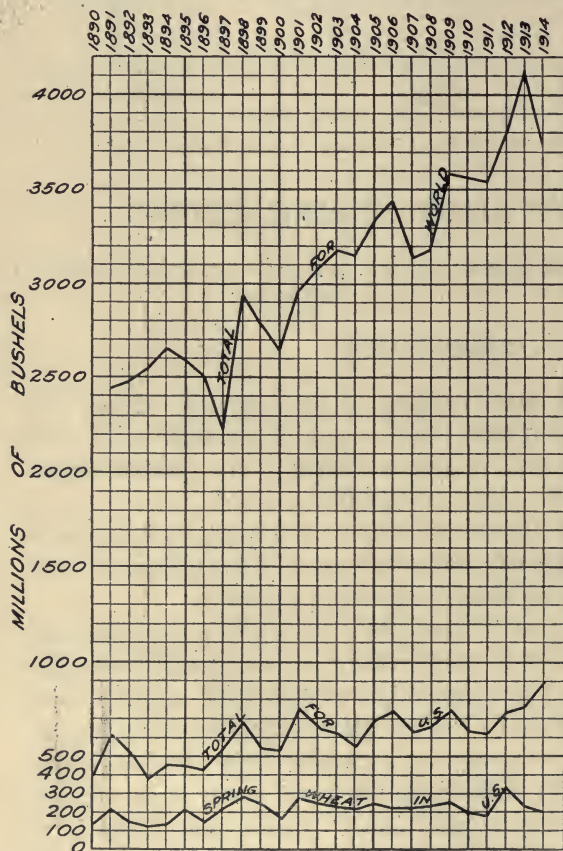


FIG. 1.—Diagram showing the millions of bushels of spring wheat grown in the United States, compared with the total wheat production in the United States and in the world, for the years 1890 to 1914, inclusive.

It is very difficult to tell just what is meant by the word variety; in fact, it means different things to different people. In general, it means a collection of plants in which all the individuals are alike in appearance, including form, size, color, and other visible characteristics.

Within such a variety usually there are many strains which, though looking alike, have different abilities and, therefore, different values.

one-third of our immense crop is spring wheat. Most of the third is grown in the northern Plains area, including Minnesota.

Figure 1 shows how much spring wheat has been grown in the United States each year for 25 years. It shows also, for comparison, how much wheat, winter and spring combined, is grown here, and how much the world grows.

Where we grow our spring wheat is shown later. (See figs. 6 and 7.)

MASS VARIETIES AND PURE LINES

Much attention is being given now to improved varieties of farm crops.

We know that two persons who look very much alike often have very different inclinations and abilities. So, too, with similar plants.

What makes the differences in the yielding ability of the different races found in any ordinary variety is not known. It has not been determined accurately in most cases. One may be more drought resistant, another more rust resistant, a third more cold resistant, a fourth simply a better yielder, and so on. An ordinary variety, probably composed of many such races, we call a mass variety.

Each single plant grows from a single seed. If the crop is self-fertilized, that is, if each flower is fertilized with its own pollen, each seed is pure and will produce a pure plant. Wheat normally is a self-fertilized crop. If seed from such a pure plant or from one of its heads is thrashed separately and sown, its descendants will be what is called a pure line. Other names for the same thing are pure strain, pure race, and pedigreed variety. A race founded thus on one pure plant remains a pure line just as long as it continues to be self-fertilized and is kept free from mixture with the seed of other races or varieties.

In open-fertilized crops, such as corn, rye, etc., where each flower usually is fertilized by pollen from another flower, and often from another plant, pure lines can be obtained only by separating single pure plants and compelling them to self-fertilize. This is done by covering the ears or heads with a paper sack or by growing the plant at a distance from other plants of its kind. Pure lines thus obtained can be kept pure only by the same means.

In any mass variety there may be several races. Some of these are likely to be good yielders and some to be poor yielders.

Plants belonging to different races often can not be told apart by outward appearance. In any field there will be many plants which belong to one race, whether the number of races be few or many. Hence, in finding the high-yielding races in the mixture, the breeder must choose a large number of plants in order to be sure he gets some of each race. He then grows their descendants separately until the experiments show how many races he has and which are the best.

These best ones are increased until the quantity of seed is sufficient and then, through various channels, they are carried out to the farms. Since they were selected for yielding power, it follows that any races worth keeping must be better yielders than the mixture of good and poor races from which they were taken.

The foregoing discussion of mass varieties and pure lines is given in order that the two kinds of varieties may be understood and the greater value of good, pure lines be recognized.

Most of the varieties discussed in this bulletin are mass varieties. Others are, or were, pure lines. Many of the mass varieties grown

in the spring-wheat section are mixed with other varieties. Some of the pure lines, too, have become mixed with other races or other varieties since they were first distributed. In most cases these mixtures are not serious enough to change varietal results.

COMMON WHEAT AND DURUM WHEAT.

The hard spring wheats of the northern section of the Great Plain area belong to two main divisions, or subspecies¹—common wheat and durum wheat—which are very distinct from each other.

HOW TO TELL THEM APART.

The plants and heads of a durum wheat and of different groups of common wheat are shown in figures 2, 3, and 4.

The common wheats have beardless or short-bearded heads (figs. 3, *b*, *c*, and *d*). The spikelets (meshes or breasts) are so far apart that they hardly overlap at all (fig. 4, *A2* and *A3*). In all the common wheats discussed in this paper the spikelets are pressed close to the stem of the head and stand nearly straight up (fig. 4, *B2* and *B3*). The head, therefore, is flattened parallel to the face of the spikelet. The beards when present are only 2 to 3 inches long. The kernels are mostly red or white, those of all the varieties commonly grown in the northern Plains being red.

The durum wheats have rather stout heads. All of them have long beards, varying from 4 to 6 or 8 inches in length (figs. 2, *a*; 3, *e*; 4, *B1*). The spikelets are set close together and overlap much (figs. 3, *e*; 4, *B1*). They stand out from the stem at a wide angle. This makes the head wider when seen from the edge (fig. 4, *B1*) than when seen from its face view (fig. 4, *A1*). In other words, the head is flattened at right angles to the face of the spikelet. The kernels are very large and very hard, and nearly all are a clear amber in color, although in a few varieties the kernels are reddish amber.

There are many common wheats, however, in Asia and elsewhere which have large, hard, amber kernels much like those of durum wheat. The bearded common wheats with such kernels do not resemble durum wheats in the least in the appearance of the head.

¹ The first division, or subspecies, is called common wheat, from the Latin name *vulgare*, which means common. The botanical name of this division is *Triticum sativum vulgare*. *Triticum* is the surname or generic name for all wheats, *sativum* the name of that large division, or species, that is used most commonly for human food. Finally, *vulgare* is the subspecific name for the common wheats, to distinguish them from the poulard wheats and the durum wheats, respectively.

The second subspecies is called durum wheat on account of its very hard kernels. The Latin name is *Triticum sativum durum*, in which the word *durum* means hard.

The common and durum wheats of this bulletin may be separated readily by the following key. There are some common



FIG. 2.—Plants of four hard spring wheats, representing durum wheat and three groups of common wheat; *a*, Kubanka (durum); *b*, Rysting (Fife); *c*, Preston; *d*, Haynes (bluestem).

wheats grown elsewhere in the United States which would not come under this description.

Heads rather slender, beardless or beards less than 3 inches long; spikelets far apart, scarcely overlapping, wide when seen in face view-----COMMON WHEAT

Heads rather stout, all bearded, beards 4 to 8 inches long; spikelets close together, much overlapping, narrow when seen in face view-----DURUM WHEAT



FIG. 3.—Heads of five groups of wheat: *a*, Turkey, a hard red winter wheat; *b*, Fife; *c*, Preston; *d*, bluestem; and *e*, durum wheat (edge view).

WHERE TO GROW THEM.

Every spring-wheat grower wants to know whether to grow common or durum wheat on his farm. A study of figure 5 will help to answer the question.

Figure 5 is a diagram showing wheat yields at 17 different experiment stations in the Great Plains area. These results were obtained partly by the State agricultural experiment stations, partly by the United States Department of Agriculture, and partly by the two in cooperation.¹

¹ Most of the data on yields presented in figure 5 and discussed herein were obtained from cooperative experiments of the Office of Cereal Investigations. Those for Hays, Kans., and North Platte, Nebr., are from unpublished records of the Office of Dry-Land Agriculture, which kindly permits their use. Published results from the State experiment stations were used for the following places:

North Dakota, Edgeley.—O. A. Thompson, Annual Reports, Edgeley Experiment Station, 1903 to 1913.

North Dakota, Fargo.—J. H. Shepperd and O. O. Churchill, "Cereal Crop Experiments," North Dakota Experiment Station Bulletin 75.

North Dakota, Langdon.—E. D. Stewart, Annual Reports, Langdon Experiment Station, 1909, 1910, 1913.

Montana, Forsyth and Harlem.—Alfred Atkinson and J. B. Nelson, "Dry-Farming Investigations in Montana," Montana Experiment Station Bulletin 83.

For each station the figure shows a series of vertical columns, shaded in different ways. The number of columns in each case shows



FIG. 4.—Heads of durum and common wheat in two positions: A, Face view of spikelets; B, edge view of spikelets. 1, Kubanka (durum); 2, bluestem; 3, Preston.

the number of different groups of wheat grown in those years. Each column stands for the best variety of its group, and the height shows

the yield in bushels per acre, as explained in the legend. The groups are hard red winter (white), durum (black), Fife (light slanting lines), Preston (heavy slanting lines), and bluestem (dotted lines).

The yields shown are the average for the number of years specified in each case. These years vary at the different stations. The yield at Edgeley, N. Dak., are for 11 years, while those at Archer, Wy.

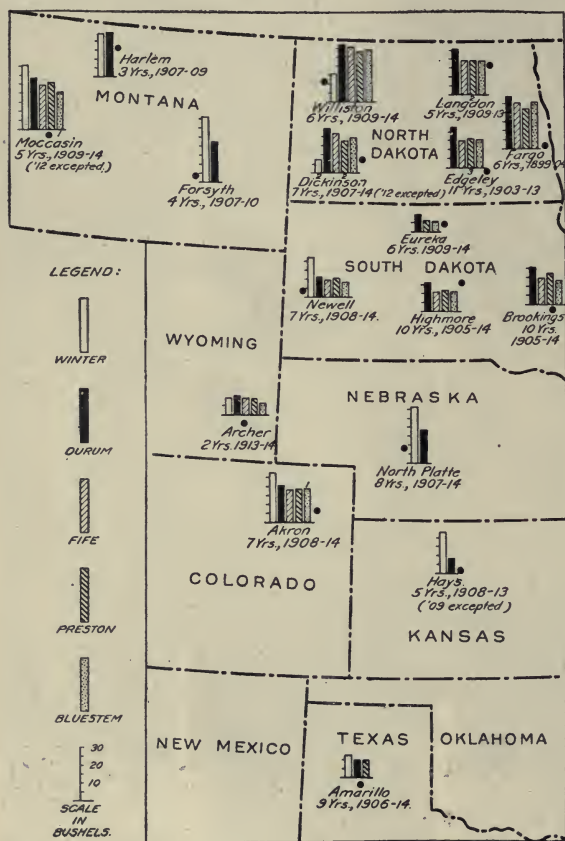


FIG. 5.—Diagram showing average yields, in certain periods of years, of the leading variety of the different groups of wheat at 17 stations in the Great Plains area. 1, Average of only 3 years (bluestem at Moccasin and Akron); 2, average of only 4 years (Preston at Langdon, winter and Preston at Dickinson); 3, average of only 6 years (Preston at Edgeley).

are for only years. The other are for periods of 3 to 10 years.

The wheat yield of one station can not be compared fully with those of the other stations because the years are different. Only at Brookings and at Highmore, S. Dak., are the years exactly the same and the yield really comparable.

At each station however, the yield of all the different groups of wheat are nearly always for the same years. The yield of any one group, therefore, may be compared safely with the yield of the other groups at the same station, except where noted.

The study of fig.

ure 5 tells us some things very plainly. Here they are:

(1) Where winter wheat (the white column) can be grown safely it is a better yielder, and in many parts a much better yielder, than any spring wheat. The figure shows roughly where winter wheat can be grown. It does not tell all the story. For local details see for fuller information.

(2) Durum wheat (the black column) has outyielded all other groups of spring wheat at all of the stations named.

We see that in the central parts of North Dakota and South Dakota the yields of durum wheat are 35 to 60 per cent higher than those of the best common wheat. Outward from this district the advantage of durum over common wheat is not so large.

In the eastern part of the Dakotas, where moisture is more abundant, its advantage is only 12 to 20 per cent over common wheat. Durum wheat was most largely grown in this eastern district in 1909 (fig. 7). Since then it has increased to the westward. Figure 5 shows that it should be greatly extended westward wherever spring wheat is better than winter wheat. Farther south it is the best spring wheat, but spring wheat is not nearly so good as winter wheat.

(3) Fife wheat (light slant-lined column) is the highest yielding common wheat in the northern and western part of North Dakota. It also is well adapted to eastern North Dakota and South Dakota and to Minnesota.

(4) The Preston group (heavy slant-lined column), as here shown, contains three different varieties. The only important one is the Preston. It gives good yields in central and eastern South Dakota, where it outyields all other groups of common spring wheat.

(5) Bluestem wheat (dotted column) is hardly equal to Fife except in eastern North Dakota. There and in Minnesota the bluestem wheats are well adapted and most largely grown.

COMMON WHEAT.

The hard red spring wheats are only one subdivision, or section, of the common wheat subspecies. Some of the other sections grown commonly in the United States are (1) the hard red winter wheats, (2) the soft red winter wheats, (3) the soft white wheats, etc. The acreage of all spring common wheat in the northwestern United States, most of it of the hard red varieties, is shown in figure 6.

The hard red spring wheats are here subdivided into three groups—Fife, bluestem, and Preston. These three groups may be separated easily by means of the following key:

Heads beardless:

Chaff white, not hairy-----1. FIFE.

Chaff white, hairy-----2. BLUESTEM.

Heads bearded:

Chaff white, not hairy-----3. PRESTON.

There are a few varieties grown here and there in the northern plains which do not belong to any of these three groups. One of them, the Galgalos, is not a hard red wheat. They will be discussed under the heading "Miscellaneous varieties."

THE FIFE GROUP.

The wheats here called the Fife group are similar in appearance and most of them are closely related. The heads are beardless and

rather slender to medium stout (fig. 2, *b*). In general, they vary in length from 3 to $3\frac{1}{2}$ or 4 inches. The Marquis, however, is somewhat shorter, usually about 3 inches. The chaff (glumes) of all varieties mentioned in this bulletin is white and without hairs (glabrous). The kernels are small to medium in size, red in color, and hard.

The following names have been used for wheats of the Fife group, at various times and places:

Assiniboine Fife, Bernard Fife, Bowman Fife, Canadian Fife, Fife, Ghirka Spring, Glasgow Fife, Glyndon Fife, Hauan, Herri-man Fife, Marble, Marquis, McKendry Fife, McKissick Fife, Minne-

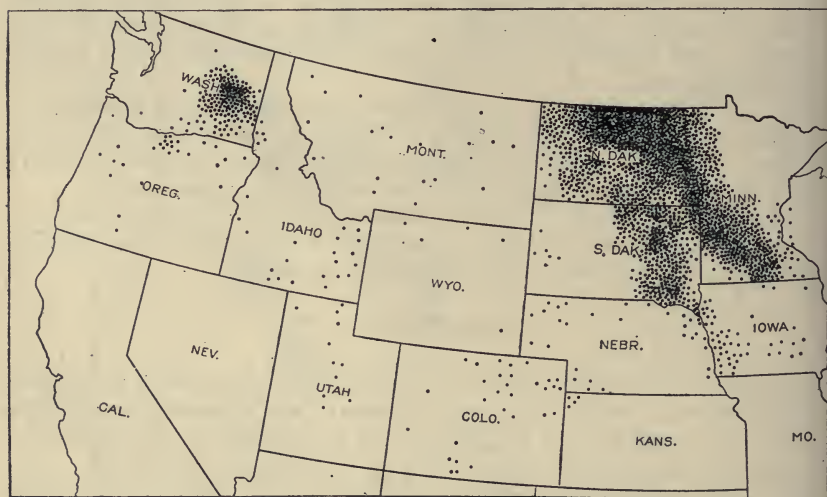


FIG. 6.—Outline map of the northwestern United States, showing where common spring wheat was grown in 1909. Note that nearly all of it is the hard spring wheat of the northern Great Plains area. Each dot represents 5,000 acres. (Figures from the Thirteenth U. S. Census, 1909.)

sota Fife, Minnesota No. 163, North Dakota No. 66, Percy, Pillsbury Fife, Power Fife, Red Fife, Rysting Fife, Saskatchewan Fife, Scotch Fife, Stanley, Verdon Fife, Wellman Fife, White Fife, and Wilcox Fife.

So far as known, 23 of these names, or all except Bowman, Ghirka, Marquis, Percy, Stanley, and White Fife, represent strains of the true Red Fife wheat.

RED FIFE.

The original Red Fife wheat is supposed to have come from Russia by way of Germany and Scotland. The story of its introduction to North America reads like a fairy tale. The record runs that about 70 years ago a Mr. David Fife, of Otonabee, Ontario, Canada, received from a friend in Glasgow, Scotland, a small sample of wheat. The friend had obtained the sample from a shipload of wheat from Germany, but supposedly of Russian origin.

Mr. Fife sowed the wheat in the spring, but it proved to be a winter wheat. However, a plant of spring wheat developed in the fall, and this was saved and increased. This wheat became known variously as Fife, Red Fife, Scotch Fife, and Canada Fife. From it were descended the strains of Fife wheat which make up so large a part of the hard spring wheat of America. These Fife wheats compose the bulk of the commercial grades "No. 1, Hard" and "No. 1, Northern," the standard spring wheats, and usually the highest priced wheats in the country.

Most of the 23 names listed as representing Red Fife wheat are merely local names. Many of them represent local stocks of seed that never became generally grown. To some extent, however, Glyndon (Minn. No. 163), Power, Rysting, and Wellman may be called definite strains of Red Fife. Each is discussed under its own name. Red Fife is grown under Cereal Investigations Nos. 3329 and 3694.

Although many lots of wheat have been imported from Russia in recent years, only once has a true Red Fife wheat been found among them. This lot (C. I. No. 2463) came from some part of Galicia, either eastern Germany or western Russia.

These Red Fife wheats are high yielders in northern and western North Dakota and good yielders over most of the hard spring-wheat section. Glyndon is most widely grown, being known as "Minnesota No. 163." Where they are suited there is little choice among them if the seed is pure and good.

Glyndon.—This widely grown strain of Red Fife dates at least from 1891, when it was first grown as No. 811 at the Glyndon farm in western Minnesota. In the burning of the Glyndon station buildings all record of its origin was lost. Without doubt, however, it was one of the many samples of Red Fife wheat obtained from Minnesota farmers in 1888 and 1889.

In 1892 a selection of this Glyndon 811 was made and given Minnesota station number 163. It has been grown and distributed by the Minnesota Agricultural Experiment Station for many years as "Minnesota No. 163," but has recently been named by them Glyndon Fife, a name which the United States Department of Agriculture had already adopted for that number. The Cereal Investigations numbers for Glyndon are 1575, 2873, and 4143.

Power.—This well-known stock is said to have been started about 1885 by Mr. James Holes, of Fargo, N. Dak., from a single plant of Red Fife wheat found growing in an oat field. Some of this seed was obtained by Mr. J. B. Power, of Power, N. Dak., who increased and distributed it in large quantities; hence the name.

Seed from Mr. Power was called North Dakota No. 66 and Minnesota No. 66, respectively, by the experiment stations in those two

States. Later selections from Minnesota No. 66 were given Minnesota numbers 149 and 276. Their Cereal Investigations numbers are 1506, 1574, 2989, 3025, 3697, and 4150.

Rysting.—This strain of Red Fife was obtained by the North Dakota Agricultural Experiment Station about 1892 from Mr. Jens Rysting, of Buxton, N. Dak. Mr. Rysting had been selecting this wheat for several years previously and claimed that it was earlier than ordinary Red Fife. This seed was taken to the Minnesota Agricultural Experiment Station and given its number 171. An incross between two plants of Rysting was made by the Minnesota station and the progeny called No. 292. The Cereal Investigation numbers for Rysting are 3022 and 4148.

Wellman.—This strain was bred by Mr. D. L. Wellman, of Frazee, Minn., from a sample of Red Fife wheat obtained from the Saskatchewan Valley, in Canada, and was sold as Saskatchewan Fife and Wellman Fife. This strain became No. 50 of the North Dakota Agricultural Experiment Station and No. 165 of the Minnesota Agricultural Experiment Station. The Cereal Investigations numbers for Wellman are 1576 and 4144.

GHIRKA SPRING.

The Ghirka Spring variety (C. I. No. 1517) came from Grodno Province, in Russian Poland. It was obtained by the Department of Agriculture at the Paris Exposition in 1900. It is probable, however, that seed has been brought to this country many times by Russian immigrants. Thousands of acres of it are grown in western North Dakota each year under the name "Russian" wheat.

It is somewhat different from the Red Fife varieties. The head is a little more slender and distinctly more tapering toward the tip. The kernel is slightly longer and paler red and a little softer than even the bluestem wheats. Ghirka is inferior in quality of flour to both the Red Fife and Bluestem varieties.

Ghirka Spring is a high-yielding Fife wheat. It has outyielded all other Fife varieties at four out of nine stations at which it has been tested in the northern Plains. In drier years its advantage over other varieties is even more apparent than in favorable seasons. In more humid districts or in wetter seasons it does not do as well. It seems more liable to injury from rust than even the bluestem wheats. Many pure races of this variety have been separated and tested. Several have been found which yield flour of good quality and these are being increased in quantity for more extensive testing. Until they are completed it is not recommended for planting.

MARQUIS.

The Marquis wheat (C. I. Nos. 3276, 3641, and 4156) is a selection from a hybrid produced by crossing a hard red wheat from Calcutta, India, and the well-known Red Fife. This cross was made by Dr. A. P. Saunders, of Ottawa, Canada, about 1892. The Marquis

was first grown as a pure line in 1904. It resembles the Red Fife. It is a little shorter than Red Fife and matures earlier. The heads are beardless, with white, hairless chaff. They are somewhat shorter and stouter than those of other Fife wheats. The kernels are hard, dark red, both shorter and plumper than those of Red Fife, and have a broader furrow.

The Marquis was developed especially for the prairie Provinces of Canada, namely, Manitoba, Saskatchewan, and Alberta. In the first two Provinces especially, Marquis has given very good results. It has outyielded Red Fife by 10 to 45 per cent. During the last two years it has been tested at eight stations in our hard spring-wheat States. Its earliness is an advantage, and it has shown itself a somewhat better yielder than Red Fife strains during these two seasons. Farmers who are now growing suitable varieties are advised not to drop them for the Marquis until the latter has proved its value in their localities. It probably rusts more readily than the true Fife wheats.

THE BLUESTEM GROUP.

The wheats of the bluestem group of the hard red spring wheats are all very similar in appearance. They also are very closely related in their origin. The bluestems of the South Atlantic and Eastern States and the Palouse Bluestem of the Pacific Northwest belong to very different groups of wheat. They should not be confused with these hard red spring bluestems.

The bluestems of this bulletin are said to have come from Russia with Russian immigrants to the United States, but this probably is not true. No varieties belonging to this group have been found among the numerous wheat introductions from Russia in recent years.

The bluestem wheats are of medium height and rather more vigorous in growth than the Fife wheats. The heads are beardless, with white hairy chaff, and are rather stouter than those of the Fifes. The kernels are hard, red, plump, and of medium size. The chaff is more loose and open than in the Fife wheats, and the kernels shatter out easily if the crop gets overripe.

The following names have been used at one time or another for the bluestem wheats:

American Bluestem, Bluestem, Bolton Bluestem, Crossbred Bluestem, Dakota Bluestem, Davis Bluestem, Haynes Bluestem, Haynes Minnesota Bluestem, Haynes Pedigreed Bluestem, Houston Bluestem, Improved Bluestem, Jackson Improved Bluestem, Marvel Bluestem, Minnesota No. 169, North Dakota No. 316, Okagagon Valley Velvet Chaff, Okanogan Bluestem, Okanogan Valley Velvet Chaff, Pedigreed Bluestem, Select Bluestem, Velvet Bluestem, Velvet Chaff.

The names Bluestem, Velvet Bluestem, and Velvet Chaff are used for the bluestem group in general. The other names have been applied to selections or local lots of bluestem wheat.

In the bluestem group there is only one variety in the real sense of the word. There are, however, certain small variations in the breeding and local origin of some of the strains. These show themselves in slight differences of earliness and yield. The strains which have become commercially important under separate names are Bolton Dakota (Select Bluestem), and Haynes (Minnesota No. 169).

BLUESTEM.

The word bluestem is used commonly as a name for this whole group and is often used also as a name for the variety grown on any given farm. This is correct in most cases, since there are no really distinct varieties in this group. However, when one of the pure or pedigreed lines is being grown it is better to call it by its variety name, as Dakota, Haynes, etc.

Bolton.—The Bolton bluestem wheat was obtained originally from Thomas Bolton, of Park River, N. Dak., by the North Dakota Agricultural Experiment Station. It was first grown at that station in 1893 under the number 146. A sample sent to the Minnesota Agricultural Experiment Station was given Minnesota number 146 also. It was recorded as being one of the best 8 out of over 200 samples of wheat collected by them before 1894. It is also found under North Dakota No. 780. Cereal Investigations Nos. 1573, 2023, and 4142 have been given it. So far as known these are all mass varieties.

Dakota.—This pure line (C. I. No. 3083) originated at the North Dakota Agricultural Experiment Station about 1898. It was selected from the original Haynes, which probably was not a pure line. It was first called by its number, North Dakota No. 316, but later was called Select Bluestem. "Select" is not really a name. Besides there are several other bluestem selections which have been called Select Bluestem.

For these reasons we prefer to name it Dakota here and hope that this name will be used. It seems proper to show in this way some recognition of the North Dakota Agricultural Experiment Station in its work with wheat. This race has been grown and distributed very extensively by that station, and probably is now the most widely grown race of bluestem wheat in that State.

Haynes.—This well-known variety originated with Mr. L. H. Haynes, of Fargo, N. Dak., about 1884. He started with an ordinary lot of bluestem wheat, and during 8 or 10 years selected it for good plants, good heads, and good kernels. It is not known whether the seed he distributed was a pure line or a mixture of several good pure lines which he had selected.

Haynes's selection was earlier than ordinary bluestem, and also had longer heads and larger kernels. It was obtained by the North Dakota Agricultural Experiment Station in 1891 and given the number 51. It was given later the same number 51 by the Minnesota

gricultural Experiment Station. Other Minnesota numbers for this variety are 161, 169, 283, 294, and 479. One well-known pure one has been widely distributed by the latter station as "Minnesota No. 169." This is also called Haynes Pedigreed Bluestem.

The Cereal Investigations numbers 1505, 1577, 2874, 3020, and 3021 have been given to different lots.

THE PRESTON GROUP.

The Preston group is made up of common bearded wheats with white, hairless chaff. The kernels are red, of medium size and plumpness, and are hard or fairly hard. They differ from the Fife wheats most noticeably in being bearded.

This group of wheats has often been called Bearded Fife, Bearded Red Fife, and Velvet Chaff. The name "Velvet Chaff" is especially misleading, because these wheats have a hairless chaff. Also, the hairy-chaffed bluestem wheats are often called Velvet Chaff in Canada and parts of North Dakota. The name Bearded Fife is not used here, because they really are not Fife wheats, and Preston is preferable, because most of the bearded spring wheat grown is the Preston variety.

The following are names that have been used for the bearded spring common wheats of the Preston group:

Bearded Fife, Bearded Red Fife, Climax, Early Java, Erivan, Fretes, Golden Fife, Java, Johnson Early Fife, Johnson Fife, Minnesota No. 188, Preston, Pringle Champion, Pringle Champlain, Red Fife, Red Russian, South Dakota Climax, South Dakota No. 67, Spring Turkey, and Velvet Chaff.

All but six of the twenty names are only other names for the true Preston variety, so far as can be learned.

Erivan, Fretes, and the so-called Red Russian and Spring Turkey all belong to the Preston group, but are distinct varieties from the Preston variety. The Pringle Champion is probably a misspelled form of Pringle Champlain, a variety found only rarely in the hard spring-wheat section.

Preston.—The Preston variety was bred from a cross between Ladoga, a Siberian wheat, and the well-known Red Fife. The hybrid was made by Dr. A. P. Saunders, of Ottawa, Canada, in 1888. It is a bearded spring common wheat with hairless white chaff and midsized and fairly hard kernels. It can be told from other members of the Preston group by the very short beaks on the outer chaff. These beaks are only one-sixteenth to three-sixteenths of an inch long.

Preston has been grown at Indian Head, Saskatchewan, since 1893. It was first grown by the Minnesota Agricultural Experiment Station in 1895 as Minnesota No. 188. It was widely distributed under this number instead of under the name Preston. Very soon the seed appeared for sale at different places under various new names.

After several years of this practice it scarcely could be found under its real name. On the boards of trade of Minneapolis and Chicago it was known as "Velvet Chaff." On the farms it was called Ear Java, South Dakota Climax, Bearded Fife, Red Fife, Minnesota No. 188, and Velvet Chaff.

Under one or another of these names Preston has given good yields in central and eastern South Dakota and is rather widely grown there. It is found commonly also in eastern North Dakota and parts of Minnesota.

Different lots of seed or different selections of Preston wheat from different sources have been given Cereal Investigations numbers. Among these are 2083, 2958 (Minnesota No. 188), 3081 (South Dakota No. 67), 3085, 3086, 3087 (these three are selections from 3081), 3318, 3328, 3691 (North Dakota No. 2366), 3692 (North Dakota No. 2393), 3698, 4153 (Minnesota No. 1011), and 4287.

Erivan.—The Erivan variety (C. I. No. 2397) was brought from the dry mountain district of the Erivan Government, in Transcaucasian Russia, near the border of Persia. It is bearded, with white, hairless glumes and red, medium-sized kernels, semihard character. It differs from Preston chiefly in the somewhat softer kernels and the longer beaks on the outer chaff.

On the high plains of eastern Colorado and Wyoming this wheat has done fairly well. It has outyielded other wheats of the Preston group, but was not better than the Fife wheats.

Fretes.—The Fretes variety (C. I. No. 1596) was obtained from Algeria, but it is almost certainly a Russian wheat. It is very similar to Erivan, but the kernels are a little larger. It may be used as winter wheat where the winters are mild; otherwise, as a spring wheat.

In the Judith Basin, in central Montana, Fretes has given good yields, as shown in figure 5. Its yield there has been better than that of any other common spring wheat.

MISCELLANEOUS WHEATS.

There are several varieties of common spring wheat in the northern Plains which do not belong to the Fife, bluestem, or Preston group. Most of them are grown only locally and are not really important. Most of them also are not of as good quality as the Fife and bluestem varieties, and the growing of them should not be encouraged.

Among these miscellaneous varieties are the Galgalos, Humpback, Huron, and Manchuria.

Galgalos.—The Galgalos variety (C. I. No. 2398) is beardless, with brown, hairy chaff and large, soft, white kernels. It came from the Erivan Government, in the Transcaucasus district of Russia, between

the Black and Caspian Seas. There it is grown as a dry-land spring wheat, and it has been so grown here.

It is a soft, white wheat, and as such is not desirable for growing in hard red-wheat district. It has proved a high yielder in the Judith basin of Montana, but for the reasons given it is not recommended. It is grown sparingly in the southern part of the Plains, in western Texas, and in western Oklahoma, but there winter wheats should always be grown if possible.

Humpback.—The Humpback variety (C. I. 3690) has bearded heads, white, hairy chaff, and a rather large, red, hard or semihard kernel. It first came to notice near Kensington, Minn., about 18 years ago. It has been called Bearded Bluestem because of the bearded heads and hairy chaff. It is now most commonly called Humpback because of the shape of the kernel.

This wheat is said to be grown now at several points in Minnesota and even in the Dakotas. There are no facts to show that it is a high yielder in the section covered by this bulletin. Where the writers have tested it, the yields have not been high. The milling quality apparently is not as good as that of the Fife and bluestem wheats. For these reasons it is not recommended.

Huron.—The Huron variety (C. I. No. 3315) is a selection from a hybrid between Ladoga and White Fife made some years ago in Canada. In appearance it differs from Preston chiefly in having light-brown chaff instead of white chaff. It perhaps is a little earlier than Preston, but it is not better in any other way. It is not recommended for growing under present conditions.

Manchuria.—The Manchuria variety (C. I. No. 2492) came from Manchuria, as the name indicates. It is an early-maturing bearded variety with hairless, reddish brown chaff and medium-sized, semi-hard red kernels. It has made a comparatively good yield at Newell, Dak., near the Black Hills. It has yielded better than the bluestem and Fife wheats, but not as well as durum or common winter wheats. Its advantage over other spring wheats at this point is due to its earliness. Its milling qualities are poor, and it should not be grown.

DURUM WHEAT.¹

The acreage of durum wheat in the United States in 1909 is shown in figure 7. Many varieties of durum wheat have been imported into this country during recent years. Only the best known varieties are here described. All durum wheats are closely related, and many are similar in appearance. They differ from the other spring wheats both in plant and kernel. The plant is usually taller and more vigorous and has wider leaves than common wheat (fig. 2, *a*).

¹ For a more complete discussion of durum wheat, see Salmon, Cecil, and Clark, J. A., Durum Wheat. U. S. Dept. Agr., Farmers' Bulletin 534, 16 pp., 4 figs., 1913.

The heads are broader, more compact, and shorter, varying in length from 2 to 2½ and 3 inches (fig. 3, *e*). The peculiar flattening of the head has been described already (fig. 4, *A1* and *B1*). The beards are longer than those of common wheat and vary with the variety and environment. The kernels are large and very hard, indicated by the name "durum." The usual color of the grain is amber, a clear yellowish brown. There are wide variations between different varieties in the general appearance of the plant and head and to some extent in the size, shape, and color of the kernel.

The principal varieties in cultivation in the United States may be assembled into groups as follows: (1) The Kubanka group, (2) the

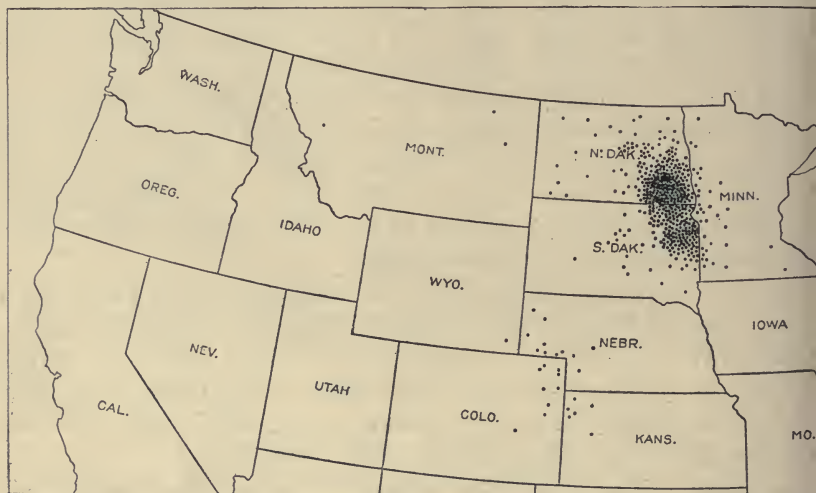


FIG. 7.—Outline map of the northwestern United States, showing where durum spring wheat was grown in 1909. Note that nearly all of it is grown in the very center of the common spring-wheat area. Each dot represents 5,000 acres. (Figures from the Thirteenth U. S. Census, 1909.)

Pelissier group, (3) the Velvet Don group, and (4) the Kahla group. These four groups may be easily separated by the following key:

Chaff yellowish:

Chaff not hairy—

Beards yellow-----1. KUBANKA.

Beards black-----2. PELISSIER.

Chaff hairy—

Beards black-----3. VELVET DON

Chaff black:

Chaff slightly hairy—

Beards black-----4. KAHLA.

THE KUBANKA GROUP.

The varieties of this group are marked by yellowish, hairless chaff and yellow beards.

The following names have been used at various times and places for varieties of the Kubanka group: Arnautka, Beloturka, Gha

ovka, Iumillo, Kubanka, Nicaragua, Pererodka, Taganrog, and Yellow Gharnovka.

Kubanka.—The Kubanka is the best known variety of durum wheat in this country. It was first introduced by the Department of Agriculture in 1900 from the Uralsk Territory in Russia, lying north of the Caspian Sea. That importation has been grown as Seed and Plant Introduction No. 5639, Cereal Investigations No. 1440, North Dakota No. 929, and South Dakota No. 75, but always under its real name, Kubanka. Other Cereal Investigations numbers given to lots of seed grown from this original lot are 2221, 2246, 2909, 2952, and 3009. A selection bred at Dickinson, N. Dak., and known as Kubanka No. 8, is Cereal Investigations No. 4063.

Several other importations of Kubanka wheat have been made, but none has proved as valuable as this one. These others are represented by Cereal Investigations numbers as follows: 518, 1220, 1258, 1349, 1354, 1424, 1490, 1516, 1581, 2094, 2234, 3303, and 3306.

The Kubanka has proved especially well adapted to the drier western portion of the northern Great Plains area. It has proved superior to other hard spring wheats in western North Dakota and in western South Dakota.

Arnautka.—Arnautka wheat is probably the most widely grown durum variety in this country. It is supposed to have been brought from Russia by early immigrants. The first importation of this variety was made by the United States Department of Agriculture in 1864. After being grown occasionally for a few years it was discontinued.

Its distribution by the Department of Agriculture dates from 1900, when seed was obtained from Mr. T. N. Oium, of Lisbon, N. Dak. (C. I. No. 1494, N. Dak. No. 778). A pure race (C. I. No. 4064) selected from this mass variety has proved a good yielder and is being distributed. Several importations were made in 1900 from Berdiansk, Russia, but these have not been widely distributed. A commercial lot of seed (C. I. No. 1493) called Wild Goose, obtained in 1901, has been distributed somewhat. Other Cereal Investigations numbers for these commercial and imported lots are 1429, 1430, 1431, 1547, 3080, 3693, and 4072.

The Arnautka variety is better suited than the Kubanka to the more humid parts of the northern Plains area. In the eastern parts of North Dakota and South Dakota, and in adjacent Minnesota, it outyields the Kubanka variety.

Beloturka, Gharnovka, and Pererodka.—The Beloturka, Gharnovka, and Pererodka varieties are all very similar to the Kubanka. The Beloturka variety (C. I. No. 1513, N. Dak. No. 919, S. Dak. No. 72) came from the Paris Exposition, but undoubtedly is of Russian origin. The name, in Russian, means white Turk. It has

given high yields in the western part of the durum-growing section but is not better than Kubanka.

The Gharnovka variety was obtained in three lots from Taganrog Don Cossacks Province, Russia. These lots were Gharnovka, C. I. Nos. 1443 (N. Dak. No. 915) and 1447 (N. Dak. No. 917), and Yellow Gharnovka, C. I. No. 1444 (N. Dak. No. 914). They have yielded slightly less than Kubanka and Arnautka in the Dakotas.

The Pererodka variety (C. I. No. 1350, N. Dak. No. 328) came from the Province of Orenburg, Russia. It probably was originally a Kubanka strain. It is a high yielder, but it has not been superior to or even quite as good as the Kubanka.

THE PELISSIER GROUP.

The three varieties so far recognized in the Pelissier group are Azizi (C. I. No. 2077), Medeah (C. I. No. 1597), and Pelissier (C. I. Nos. 1584 and 2086).

The only one grown in the northern Plains is Pelissier (C. I. No. 1584), which was developed by a man of that name in Oran, Algeria. It has been a high-yielding variety at some points in the western part of the spring-wheat section, but has not become generally cultivated.

THE VELVET DON GROUP.

Belonging in the Velvet Don group are Richi (C. I. No. 2089) and Velvet Don (C. I. Nos. 1445 (N. Dak. No. 930), 2222, and 2247).

This black-bearded variety with hairy chaff was introduced from the Don Cossacks Province of Russia by the United States Department of Agriculture in 1900. It has not proved as good a yielder as Kubanka and other varieties, and the flour yields are comparatively low. It is mentioned here only because it is occasionally found on farms in the section discussed.

THE KAHLA GROUP.

Only the Kahla (C. I. Nos. 1595 and 2088) and the Purple Durum (C. I. No. 3024) are placed in the Kahla group. The Kahla is a black-chaffed, black-bearded variety, commonly grown by the Arabs in Algeria. It is there considered one of the best varieties of durum wheat and is held to be adapted to a wide range of adverse conditions. It has been tested in this country, but not distributed to any extent and is only occasionally found on the farms.

Day



FARMERS' BULLETIN



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Contribution from the Bureau of Entomology, L. O. Howard, Chief.

THE SILVERFISH;¹ AN INJURIOUS HOUSEHOLD INSECT.

By C. L. MARLATT,

Entomologist and Acting Chief in Absence of Chief.

INTRODUCTION.

The silverfish (fig. 1) is often one of the most troublesome enemies of books, papers, card labels in museums, and starched clothing, and occasionally of stored food substances. Its peculiar fishlike form and scaly, glistening body, together with its very rapid movements and active efforts at concealment whenever it is uncovered, have attached considerable popular interest to it and have resulted in its receiving a number of more or less descriptive popular names, such as silverfish, silver mouse, silver witch, sugarfish, etc. The species named above is the common one in England, but it also occurs in this country, and, like most other domestic insects, it is now practically cosmopolitan. It has a number of near allies, which closely resemble it, both in appearance and habits. One of these, (*Lepisma*) *Thermobia domestica* Pack., has certain peculiarities of habit which will be referred to later. The unusual appearance of the common silverfish early drew attention to it, and a fairly accurate description of it, given in a little work published in London in 1665 by the Royal Society, is interesting enough to reproduce:

It is a very small, silvery, shining worm or moth which I found much conversant among books and papers, and is supposed to be that which corrodes and eats holes

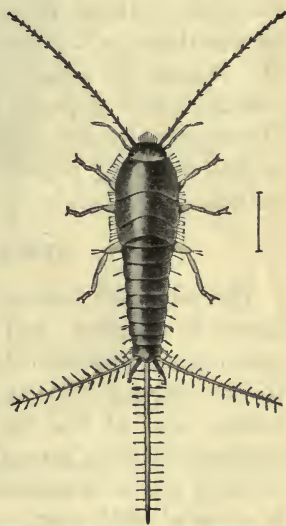


FIG. 1.—The silverfish (*Lepisma saccharina*): Adult. Enlarged. (Original.)

¹ *Lepisma saccharina* L. Thysanura, family Lepismatidæ.

through the leaves and covers. It appears to the naked eye a small, glittering, pearl-colored moth, which upon the removing of books and papers in the summer, is often observed very nimbly to scud and pack away to some lurking cranny where it may better protect itself from any appearing dangers. Its head appears big and blunt and its body tapers from it toward the tail, smaller and smaller, being shaped almost like a carret.¹

HABITS AND INJURY.

On account of its always shunning the light and its ability to run very rapidly to places of concealment, it is not often seen and is most difficult to capture, and being clothed with smooth, glistening scales it will slip from between the fingers and is almost impossible to secure without crushing or damaging. It is one of the most serious pests in libraries, particularly to the binding of books, and will frequently eat off the gold lettering to get at the paste beneath, or, as reported by the late P. R. Uhler, of Baltimore, often gnaws off white slips glued on the backs of books. Heavily glazed paper seems very attractive to this insect, and it has frequently happened that the labels in museum collections have been disfigured or destroyed by it, the glazed surface having been entirely eaten off. In some cases books printed on heavily sized paper will have the surface of the leaves a good deal scraped leaving only the portions covered by the ink. It will also eat any starched clothing, linen, or curtains, and has been known to do very serious damage to silks which had probably been stiffened with sizing. Its damage in houses, in addition to its injury to books, consists in causing the wall paper to scale off by its feeding on the starch paste. It occasionally gets into vegetable drugs or similar material left undisturbed for long periods. It is reported also to eat occasionally into carpets and plush-covered furniture, but this is open to question.

STRUCTURE AND RELATIONSHIPS.

The silverfish belongs to the lowest order of insects—the Thysanura—is wingless, and of very simple structure. It is a wormlike insect about one-third of an inch in length, tapering from near the head to the extremity of the body. The head carries two prominent antennæ, and at the tip of the body are three long, bristle-shaped appendages, one pointing directly backward and the other two extending out at a considerable angle. The entire surface of the body is covered with very minute scales like those of a moth. Six legs spring from the thorax, and, while not very long, they are powerful and enable the insect to run with great rapidity.

In certain peculiarities of structure, and also in their habits, these anomalous insects much remind one of roaches, and their quick gliding movements and flattened bodies greatly heighten this resemblance. More striking than all, however, is the remarkable development of the coxæ or basal joints of the legs in the silverfish, which

¹ Hooke, R., *Micrographia*, p. 203-210. London, 1665.

nds its counterpart in roaches, and, taken in connection with the other features of resemblance, seems to point to a very close alliance between the two groups, if, indeed, the silverfish are not merely structurally degraded forms of roaches and to be properly classed with the Blattidæ.

ANOTHER COMMON SPECIES.

Another common silverfish of this country, referred to in the opening paragraph, has developed a novel habit of frequenting ovens and fireplaces, and seemingly revels in an amount of heat which would be fatal to most other insects. It disports itself in numbers about the openings of ranges and over the hot bricks and metal, manifesting a most surprising immunity from the effects of high temperature. This heat-loving or bakehouse species (fig. 2) was described in 1873 as *Lepisma domesticum* by Packard, who reported it to be common about fireplaces at Salem, Mass. This species is also very abundant in Washington. What is evidently this same insect began to be noted commonly about 1895 in England and on the



FIG. 2.—The "fire-brat" (*Thermobia domestica*): Adult female. Enlarged. (Original.)

continent, where it manifests the same liking for hot places exhibited by it in this country. The habit of this species of congregating about bakehouses and dwellings, about fireplaces and ovens, has given rise to the common appellation in England of "fire-brat." Similar descriptive names are applied to it also on the Continent. This species closely resembles the common silverfish in size and general appearance, but may be readily distinguished from it by the presence on the upper surface of dusky markings. It also possesses well-

marked structural differences, which have led to its late reference to a distinct genus—*Thermobia*. An Italian entomologist, Rovelli, has described this insect under the descriptive name *furnorum* from its inhabiting ovens, and the name of the genus to which it is now assigned by English entomologists is also descriptive of its heat-loving character. A Dutch entomologist, Oudemans, reports that he has found it in abundance in all bakehouses that he has examined in Amsterdam, where it is well known to bakers and has received a number of familiar names.

REMEDIES.

Advantage may be taken of the liking of these insects for fabrics and other articles containing starch to poison them by slipping into all the crevices where they occur—in bookshelves and backs of mantels under washboards, and in the bottoms of drawers—bits of cardboard on which a thin boiled starch paste poisoned with from 3 to 5 per cent powdered white arsenic has been spread and dried. The arsenic should be added to the flour and sufficient water used to make a thin paste by boiling. One of our correspondents reports complete relief by this measure.

The silverfish readily succumbs to pyrethrum, and wherever this can be applied, as on bookshelves, it furnishes one of the best means of control.

Sodium fluorid,¹ now recognized as one of the most efficient roach powders, will doubtless also be equally effective against silverfish. Where such course is possible it may be dusted by hand or with a powder blower in the situations where silverfish occur.

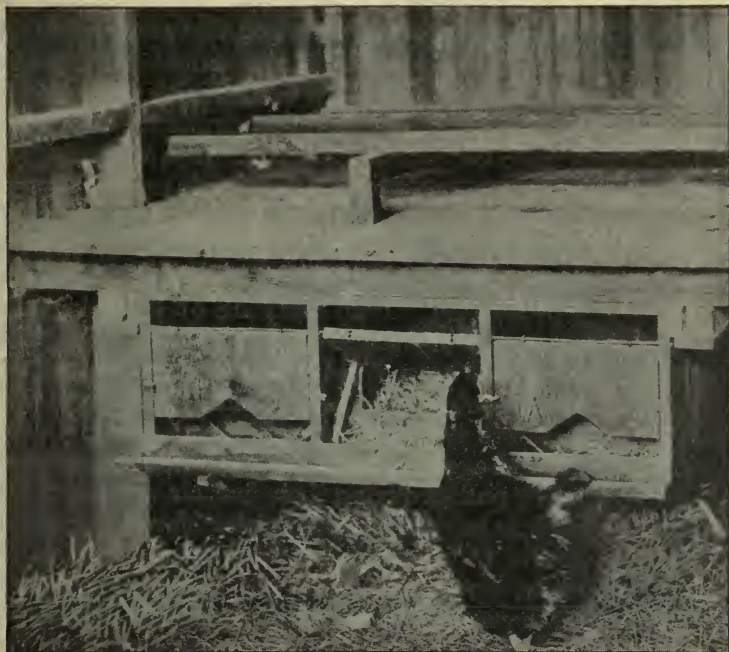
For starched clothing and similar objects liable to injury by infrequent handling and airing and the destruction by hand of all specimens discovered is to be recommended, in addition to the remedies noted above. Little damage is likely to occur in houses except in comparatively moist situations or where stored objects remain undisturbed for a year or more.

¹ Marlatt, C. L. Cockroaches. U. S. Dept. Agr., Farmers' Bulletin 658, 15 p., 5 fig., 1915. Reference to sodium fluorid against roaches, p. 12.

A SIMPLE TRAP NEST FOR POULTRY

ALFRED R. LEE

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A SIMPLE TRAP NEST FOR POULTRY.

WHAT THE TRAP NEST IS.

A TRAP NEST is a laying nest so arranged that after a hen enters it she is confined until released by the attendant. The trap nest shown in the accompanying illustrations is used with good results on the Government poultry farm, and is quite similar to the nest used at the Connecticut State Experiment Station. It is very simple and may be built readily by any one who is handy with tools.

The use of trap nests is essential in breeding poultry for both egg production and exhibition, where pedigree records are used in selecting either the males or females, and has a place in mass selection for increasing the egg production. Trap nests are of value in weeding out poor layers and increasing the average egg yield of a flock by selecting and breeding, but are not generally used on account of the large amount of labor required to operate them. They have a place on breeding farms where they can be used in selecting the better layers and the stock and eggs for breeding purposes. Some poultry breeders trap-nest their pullets during their first six months of laying and use this as a basis in selecting their breeders for egg production.

One trap nest should be provided for each 4 hens kept in flocks of 50 or more, while more trap nests per hen are necessary in smaller flocks. The hens are banded with numbered bands, and a record is kept of their egg production. The nests should be visited at least four times daily, and preferably much more often, frequent trips being especially necessary when the hens are laying freely and during hot weather.

This trap nest may be attached to the underside of the dropping board, with the front facing the pen and arranged so that it can be easily removed, or it may be placed on the walls of the pen. If the nest is placed under the dropping board, the latter will serve as a top for the nest, and the rear of the nest may be of wire to allow good ventilation in warm weather. If the nest is placed on the wall, slats or wire should be inserted from the front of the nest to the wall at a sharp angle to prevent the hens from roosting on the nest.

When the hen enters this nest her back raises the door (*c*) (fig 2), which releases the catch or trigger (*a*) and allows the door to shut. The catch should be set so that its edge just holds the door, which position is regulated by the screw or nail at the lower inside edge of the catch. Washers should be placed on the screw (*d*) on both sides of

the catch or trigger to prevent it from sticking. The guard (*b*) around the catch keeps the nesting material away from the catch. The length of the catch which supports the door and the triangular notch in the door may be varied slightly for very small or very large hens if this is found necessary.

CONSTRUCTING A THREE-COMPARTMENT NEST.

Cut four $\frac{7}{8}$ -inch boards for ends and partitions, 12 inches wide by $18\frac{1}{2}$ inches long, enough $\frac{1}{2}$ -inch boards $39\frac{1}{2}$ inches long, laid lengthwise, to cover the top, back, and bottom, and two strips $39\frac{1}{2}$ inches long and $1\frac{1}{2}$ inches wide for the front of the nests and for the front extended rail. Cut three pieces of $\frac{1}{2}$ -inch boards 12 inches long and 3 inches high to insert in the nest to hold the nesting material away

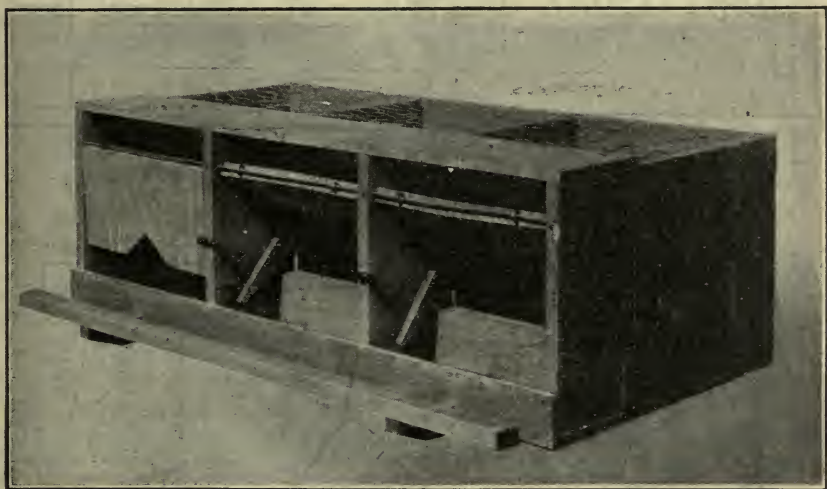


FIG. 1.—A three-compartment trap nest. Two of the doors are shown open and one closed.

from the door. The total quantity of material needed will be one $\frac{7}{8}$ -inch board, 12 inches wide by 8 feet 2 inches long for the ends, partitions, and front of the nest; and two $\frac{1}{2}$ -inch boards 10 inches wide and 10 feet long for the top, back, bottom, and front rail of the nest. If wire is used on top of the nest an equal number of square feet of $\frac{1}{2}$ -inch lumber can be subtracted from the amount stated.

Nail the top, back, and bottom to the ends and partitions (see fig. 2), insert the 3-inch strips in the nests, and make the guard (*b*), nailing it to the left side of the nest. Bore a hole in the catch (*a*) large enough so that the catch will move freely when screwed into position on the side, and use a washer on both sides of the catch. The catch should be made of hardwood, so that it will not wear readily around the screw which holds it in place. The catch is made of material $\frac{1}{2}$ inch thick and is $1\frac{1}{2}$ inches wide at the upper end and $\frac{3}{4}$ inch wide at the lower end. Place a screw at the lower edge of the catch to stop it when set, so that the catch will just hold the door.

Make the doors (*c*) of $\frac{3}{8}$ -inch material, 12 inches by 6 inches, and cut a triangular notch in the center 4 inches wide. Put two screw eyes in the top of the doors and bore holes in the front of the nests 2 inches below the top (inside measurement), through which a $\frac{3}{16}$ -inch wire is run to support the doors.

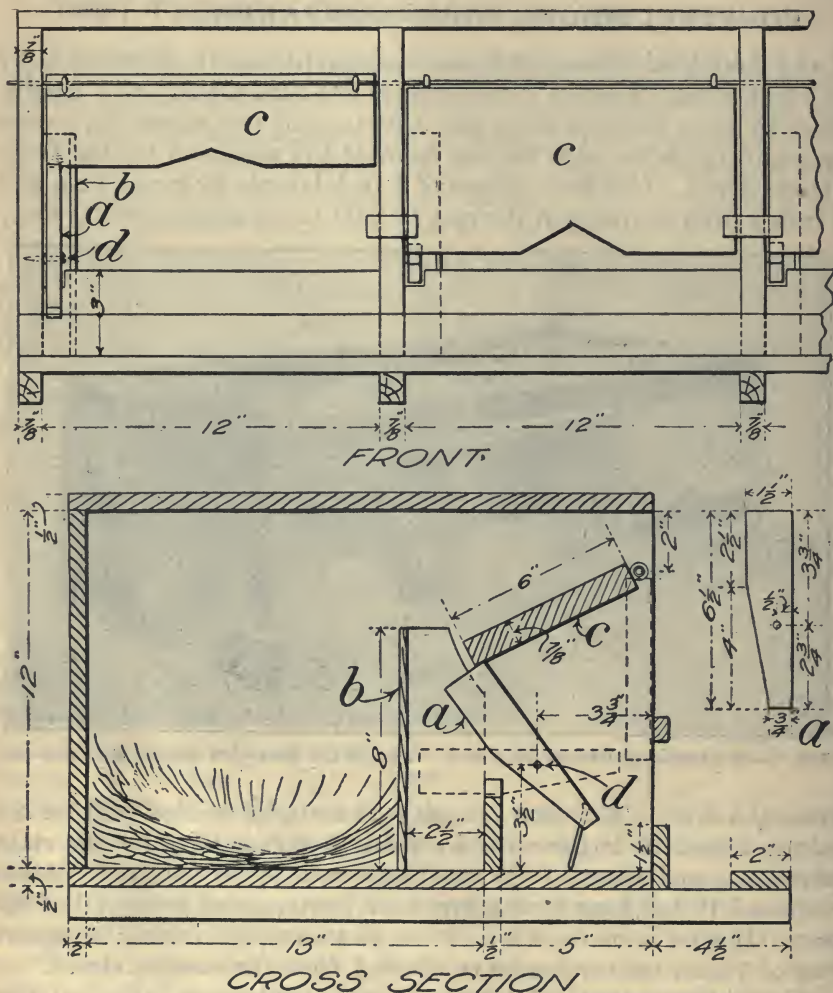


FIG. 2.—Details of construction of trap nest.

Attach a narrow strip to the front of the nests for the hens to jump upon when entering the nests. Place a button or block of wood on the front of each partition to hold the door when the nest is closed.

If the nests are to be placed directly below the dropping board, a wire top should be used on the nest, except for a 5-inch strip of wood on the front edge of the top to stiffen the nest.

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FLEAS AS PESTS TO MAN AND ANIMALS, WITH SUGGESTIONS FOR THEIR CONTROL.

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INTRODUCTION.

Fleas are of importance to man in two ways: First, as disease carriers and, second, as parasites or annoyers of man and animals. The dread disease of man known as bubonic plague has been found to be transmitted largely, if not entirely, through the agency of these insects. A disease known as infantile kala azar, occurring in the countries bordering the Mediterranean Sea, is probably also transmitted by them, and a species of tapeworm which infests dogs and occasionally people has been found to pass at least one stage in the dog flea, then gaining entrance to a new host by the swallowing of crushed or living fleas. As parasites of man and animals fleas are of considerable importance aside from disease transmission. In many instances they have been known to render houses uninhabitable for a time, and certain species cause considerable loss among poultry as well as annoyance to other animals.

LIFE HISTORY AND HABITS OF FLEAS.

It should be borne in mind that there are a great many different kinds of fleas. Most of these are of no importance to man, as they feed on various wild birds and mammals. Nearly all species have some one host upon which they prefer to live, but they may feed upon other animals and often thrive upon them.

As examples may be cited the dog flea (fig. 1),¹ which normally feeds on dogs and cats, but which when excessively numerous may prove a troublesome pest to man. The human flea normally attacks man, but may be found on a number of other animals. Rat fleas, in the absence of their usual hosts, will bite man, and it is in this instance that fleas are responsible for the inoculation of man with bubonic plague.

There is a marked variation in the habits of fleas in regard to the intimacy with which they are associated with their hosts. Some kinds remain upon host animals practically all of the time. In fact, the chigoe flea normally buries itself in the skin of the host and there develops its eggs and dies. The sticktight flea, or chicken flea, has this habit of intimate association with the host, but does not bury itself in the flesh of the animal. Dog fleas ordinarily remain upon the domestic animals almost continuously throughout their existence, but are not attached, feeding only at intervals. The human flea has adapted itself to its host so closely that it remains upon man but little, being free the greater portion of the time.

There are four different stages in the life of fleas, as is the case with many other insects; these are the egg, larva, pupa, and adult.

A number of eggs are deposited by each adult flea. The egg laying, alternated with feeding, extends over a considerable period of time. In most cases the ova are deposited by the fleas while the latter are on the host, but as they usually are not cemented to the hair or feathers they fall out in the nest or resting place of the animal. The eggs are white or cream in color and ovoid in shape. Large numbers of them may often be seen on mats or cushions upon which infested dogs or cats sleep. Especially are they easily observed when on dark-colored cloths. The egg of the common dog flea is illustrated in figure 1 at *a*. Hatching usually takes place in from 2 to 12 days.

The larva when first hatched is very minute, of whitish color, and quite active. (See fig. 2, larva of European rat flea.) In this stage none of the fleas is parasitic. They depend upon various animal and vegetable debris, including the excrement of the adult fleas, for food. During their growth the skin is shed two or three times, and between four days and several months after hatching a silken cocoon is spun, and in this the larva transforms to the pupal or resting stage. (See fig. 1, *b* and *c*, pupa of dog flea.)

¹ The fleas mentioned in this bulletin are known scientifically as follows: Dog flea, *Ctenocephalus canis* Curtis; cat flea, *Ctenocephalus felis* Bouch.; human flea, *Pulex irritans* L.; rat fleas, *Xenopsylla cheopis* Roth. (the Indian rat flea), *Ceratophyllus fuscatus* Bosc. (the European rat flea), and others; chigoe, *Dermatophilus penetrans* L.; sticktight or chicken pox flea, *Echidnophaga gallinacea* Westw.

The insect remains within the cocoon for a period which may range from three days to more than a year. The cocoon of the dog flea is illustrated in figure 1 at *b*. The dark curved object within is the larva just before pupating.

The complete life cycle of members of this group of insects may be passed in as short a period as 19 days, but during cool weather

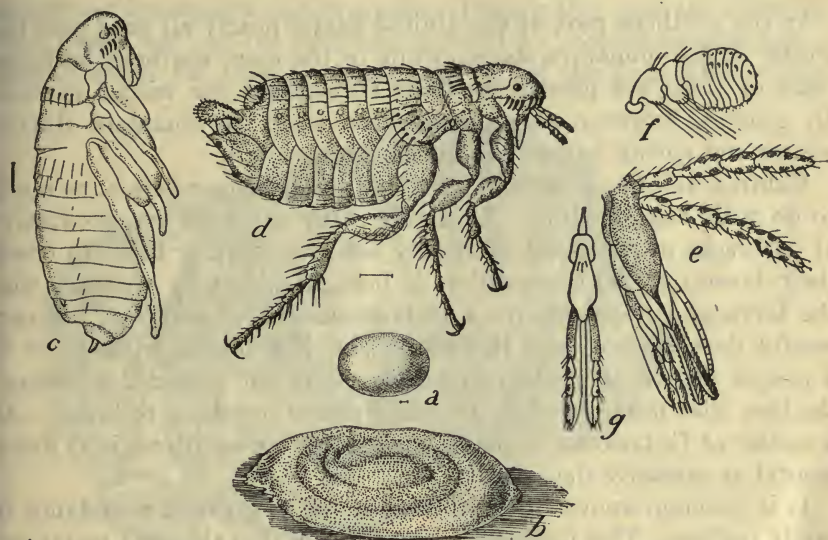


FIG. 1.—The dog flea: *a*, Egg; *b*, larva in cocoon; *c*, pupa; *d*, adult; *e*, mouth parts of same from side; *f*, antenna; *g*, labium from below. *b*, *c*, *d*, Much enlarged; *a*, *e*, *f*, *g*, more enlarged. (From Howard.)

or under adverse conditions the total period from egg to adult may extend considerably over a year.

HOW LONG THE ADULT WILL LIVE.

The length of life of the mature flea varies much in different species and also under different atmospheric conditions. During

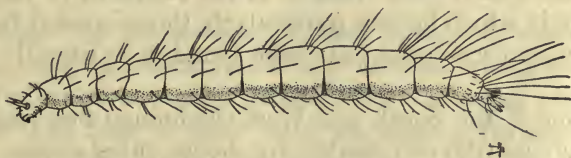


FIG. 2.—The European rat flea: Larva. Greatly enlarged. (Author's illustration.)

hot, dry weather, and when no animals upon which to feed are present, the duration of life is exremely short—two to five days. When allowed to feed on blood, which is the only food taken by the adults, they may live from a month to almost a year. During sum-

mer probably the average longevity of the human flea without food is about two months, of the dog flea somewhat less, and of the stick-tight flea still less.

ABUNDANCE OF FLEAS IN RELATION TO SEASON, CLIMATE, AND OTHER CONDITIONS.

In the northern part of the United States nearly all fleas pass the winter in the immature stages, while in the more southern latitudes some of them are present on hosts throughout the winter months. In general, however, these insects are never as abundant during winter and spring as they are in summer and fall.

Rainfall and the amount of moisture in the atmosphere have much to do with flea breeding. As a rule rainy summers are productive of outbreaks of fleas, and extremely hot, dry weather tends to check their breeding. This condition is brought about by the fact that the larva and pupa require a certain amount of moisture for successful development, and the adults also live longer when there is a proper degree of moisture present. It is not intended to convey the idea that fleas require very moist places in which to breed. As a matter of fact, excessive moisture in the breeding places is as detrimental as excessive dryness.

It is common knowledge that fleas occur in greatest abundance in sandy regions. This is explained by the fact that the sand maintains a more uniform moisture condition and thus permits the immature stages of the flea to develop with greater success. The sand also offers some protection to the adults and renders heavy rains less destructive to all stages of the flea present on the soil.

FLEAS AS PESTS IN THE HOUSEHOLD.

As has been pointed out,¹ in the eastern part of the United States the dog flea is the species of greatest importance as a household pest. Many instances have been brought to the attention of the Bureau of Entomology in which houses, particularly those vacated for some time during the summer months, have been found to be literally overrun by these pests.

In portions of the South and West the human flea (figs. 3 and 4) is the one primarily responsible for house infestations. Although the host relationship of these two species is somewhat different, the same methods of control are applicable, for the most part, to both.

¹ Howard, L. O. House Fleas. U. S. Dept. Agr., Bur. Ent., Cir. 108, 4 p., 2 fig., Feb. 11, 1909.

The conditions which give rise to outbreaks in houses, particularly in the case of the dog flea, are usually these: Pet dogs or cats are kept about the household during the spring and early summer, and great numbers of eggs are deposited upon them by the fleas. These eggs are scattered about the floors and soon hatch into minute maggots which feed upon the vegetable and animal matter under carpets and mattings and in cracks. During this time the house has been closed up and the breeding allowed to proceed unmolested, so that at about the time the occupants return the fleas have reached

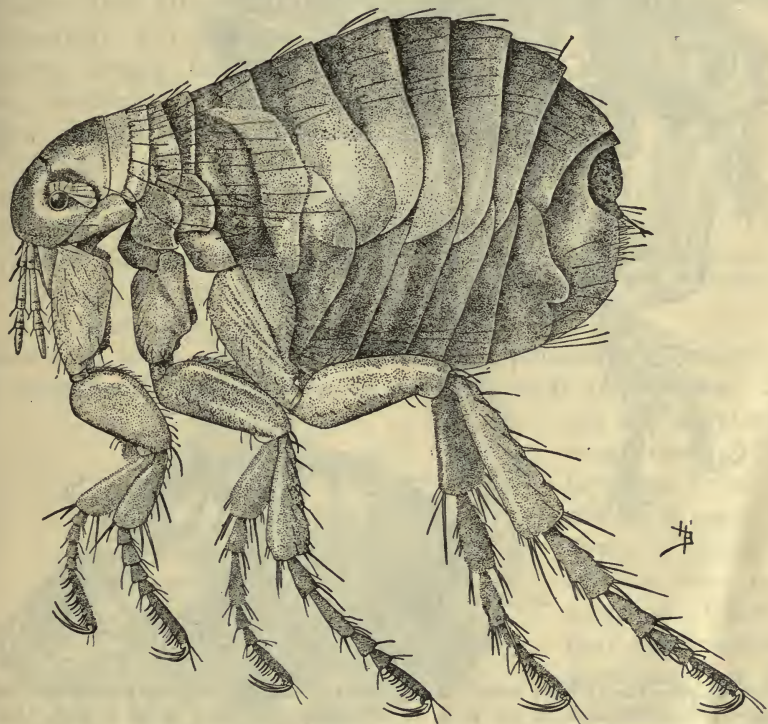


FIG. 3.—The human flea: Adult female. Greatly enlarged. (Author's illustration.)

the adult stage. In the absence of other hosts they are exceedingly hungry and ready to attack man or any animals which are accessible.

Some infestations of residences come from breeding places beneath the houses. The fleas in these cases are usually furnished by stray animals which sleep under the buildings. The immature stages develop in the accumulation of dust and vegetable matter in the beds of these animals. Instances are not uncommon where such infestations may extend to lawns, barnyards, and, in fact, all over the premises, although as a rule the center of infestation is in some one definite place frequented by animals.

The infestations of the human flea are usually less heavy than in the extreme cases above mentioned, and the breeding places are often more widely extended.

A number of instances in the Southern and Central-Western States have come to notice where hogs appear to have been the source of gross infestations of the human flea. The adult fleas feed on the hogs, and breeding takes place in the beds of these animals. In some



FIG. 4.—The human flea: Adult male. Greatly enlarged. Note the difference in the shape of the abdomen of the male as compared with that of the female (fig. 3). (Author's illustration.)

instances the source of infestation is in the hog runs, but more usually it is derived from hogs sleeping under houses.

FLEAS INJURIOUS TO POULTRY AND DOMESTIC ANIMALS.

Fortunately the higher domestic animals are comparatively free from flea attacks. Horses, cattle, sheep, and goats are very seldom annoyed, although a few instances have come to our attention in which the sticktight flea infested horses. Hogs are infested to some extent, but seldom heavily enough to do any damage.

THE STICKTIGHT FLEA.

The sticktight flea, or southern chicken flea, is probably the most important of our live-stock infesting species. This form attacks a number of different hosts, including poultry, dogs, cats, and some wild animals. As has been stated, the adult fleas remain during the greater part of their lives attached to the host animal. On dogs and cats they are largely found on the ears, particularly along the edges. In the case of poultry infestations fleas are most common on the heads of the hosts, where they are to be seen in groups or patches. This habit of attaching in clusters seems to be well marked, and an infested fowl often may be recognized at a considerable distance by the dark flea-covered areas about the eyes, comb, and wattles. Figure 5 illustrates the usual mode of infestation on a chicken's head, and figure 6 shows one of the fleas much enlarged. When the fleas are excessively abundant they may be found in similar patches on the neck and various parts of the body.

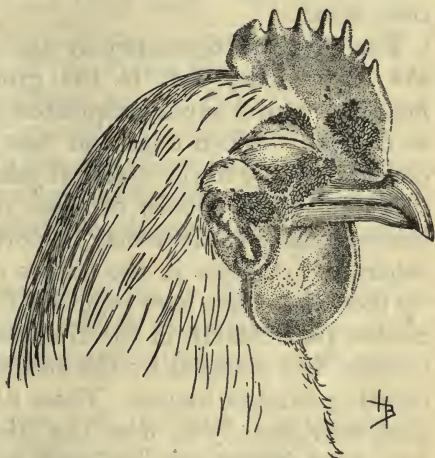


FIG. 5.—Head of rooster infested with the sticktight flea. Somewhat reduced. (Author's illustration.)



FIG. 6.—The sticktight flea: Adult female. Much enlarged. (Author's illustration.)

This flea is most common and of greatest importance in the Southern and Southwestern States. It has been reported as injuri-

ous to poultry as far north as Kansas. The injury is most marked in young chickens, which when fairly heavily infested often die

quickly. Older fowls are more resistant, but have been known to succumb to very heavy infestations; and certainly the fleas materially reduce egg production, retard the growth of fowls, and diminish their size.

The eggs are deposited by the adult flea while it is attached to the host. They fall to the ground under the roost in chicken houses or under sheds frequented by the poultry and there continue to develop. When dogs and cats are infested the immature stages develop largely in the material used by them for beds.

A few other species of fleas are occasionally found in poultry houses. Some of these may be normally bird-infesting species, while others are at home in the houses of domestic poultry. Infestations by these fleas have been reported from several places in the Northern States, particularly in the Northwest. The presence of the fleas is usually first detected by the adults getting on the bodies of persons entering chicken houses. These fleas do not remain attached to the host continuously as does the sticktight flea. They are seldom of any great importance and may be controlled by the same methods outlined on pages 13 and 14.

DOG AND CAT FLEAS.

Dogs and cats are infested by two very closely related species of fleas,¹ and these appear to feed more or less interchangeably on the two hosts, as well as occasionally on man and other animals. While they cause these hosts much annoyance and, as has been pointed out, are also responsible for the infestation of dogs by tapeworms, serious injury seems to be rare. However, in the case of valuable dogs and cats it is often desirable to rid them of fleas, and in all cases where these animals are closely associated with man the control of the fleas upon them is of importance. As will be seen by comparing figure 1 with figure 6, the dog flea is quite different from the sticktight flea in structure as well as in size. The adults do not remain attached to the host in one place, but the life history is not vastly different from that of the sticktight flea. Breeding takes place in similar materials in situations occupied by the host animals. Mr. Theodore Pergande, working with the dog flea at Washington, D. C., found the life cycle from egg to adult to be completed within 17 to 37 days. It is thus seen that a great number of fleas might be bred in and beneath an unoccupied house in a comparatively short period.

Both of these species have a very wide distribution, being found in practically all parts of the world where dogs and cats are found.

¹The cat flea is known scientifically as *Ctenocephalus felis* Bouché, and the dog flea as *Ctenocephalus canis* Curtis. The human flea also is not uncommonly found on dogs and cats.

FLEAS IN RELATION TO BUBONIC PLAGUE.

During recent years bubonic plague has been introduced into the United States on both the Pacific and Gulf coasts. The infestation in California persisted for a number of years, although it was closely held in check through the efforts of the Public Health Service and the State board of health. The disease around San Francisco not only persisted among the rats, but gained a foothold among ground squirrels in the counties adjacent to San Francisco Bay. A strenuous fight is being waged against rats in all of the Pacific ports and against ground squirrels in the territory where the disease has become established among these rodents.

During the year 1914 the disease broke out in New Orleans, but strict quarantine measures and an energetic campaign against the rats kept the malady from spreading and limited the number of human cases.

While the plague situation is now well in hand it is important that all have a general knowledge of the essential steps in controlling the disease. The prevention of the introduction of bubonic plague depends to a considerable extent upon quarantine regulations at our ports of entry, but it is of even greater importance that united effort be put forth to control the rats in the seaport towns. The work should not stop here, as it is of importance that concerted action be taken against rats and ground squirrels throughout the entire country.

It may be gathered from what has been said that the control of bubonic plague depends almost entirely upon the destruction of the rat population. This is essential in that the disease always starts by gaining a foothold among the rats, and as these animals die and the fleas leave them and attack man the human cases of plague begin.

In addition to the importance of rat control from the standpoint of disease prevention there is every reason to wage war against these pests on account of their importance as destroyers of agricultural and other products. It has been estimated that the loss in the United States due to rats exceeds \$100,000,000 annually. The principal methods of combating these rodents¹ are rat proofing, trapping, poisoning, and destruction by natural enemies.

With the reduction in numbers of rats and mice the various species of fleas which infest them and which in turn may play a part in carrying bubonic plague are greatly reduced in numbers. The cleaning up of the breeding places of rats and the destruction of their nests will also accomplish the extermination of a large number of fleas in the immature stages. Some of the methods of trapping fleas mentioned under "Means of Repression" will aid in destroying those

¹ The methods of rat control are discussed in Farmers' Bulletin 369, U. S. Department of Agriculture, by Mr. D. E. Lantz, of the Bureau of Biological Survey.

which may have fed on rats and are therefore dangerous as regards disease transmission.

Persons resident in districts where plague occurs among the ground squirrels should remember that there is danger of infection from the bites of fleas which infest these animals.

MEANS OF REPRESSION.

Certain general principles regarding the control of fleas are applicable to nearly all species, but some modifications of the methods employed are necessary for different species and under the different conditions in which they exist.

METHODS OF COMBATING HOUSEHOLD INFESTATIONS.

As has been pointed out, the dog flea and the human flea are the two most important species invading the habitations of man. It has also been suggested that the adult fleas feed more or less on cats and dogs and that the immature stages develop in the cracks of floors and beneath houses. It is at once apparent that two steps are necessary to cope with the pest: (1) The destruction on the host of the adults which are producing the eggs, and (2) the clearing out of the immature stages which are breeding in or under the house.

THE DESTRUCTION OF FLEAS ON CATS, DOGS, AND HOGS.

One of the most successful methods of killing fleas on cats and dogs is to wash the animals thoroughly in a tub containing the proper proportion of a saponified coal-tar creosote preparation, of which there are a number on the market, known as "stock dips," etc. The animals should be thoroughly scrubbed, making sure that the fleas on the head are well soaked, as many rush there to get away from the parts that are covered with the solution. After the animal has been in the bath for about 5 or 10 minutes it may be removed and allowed to dry. In the case of cats, especially if tender skinned, the preparation may be washed out of the fur with soap and warm water soon after the animal is taken out of the solution.

In addition to the destruction of all fleas present, this accomplishes the cleansing and deodorizing of the fur and also aids in the healing of any wounds which are present.

Other methods of destroying fleas on cats and dogs have been recommended. Among these the careful rubbing into the hair of powdered naphthalene or moth balls has been found effective. Pyrethrum or Persian insect powder is used in the same way. Both of these materials stupefy the insects and cause them to come to the

surface of the hair or actually drop out. The animals should be treated on papers spread on the floor and the insects burned after the dusting is completed.

Fleas on hogs may be destroyed by dipping the animals in a vat containing some of the creosote dips as used for the hog louse or by sprinkling crude petroleum on them when they are eating.

CONTROL OF HOSTS.

In order to avoid the infestation of houses, it is important to keep all animals from beneath dwellings. In such situations breeding may progress rapidly, and it is very difficult to treat the breeding places. If fleas are continuously annoying about the household, it is often desirable not to admit cats and dogs at all, but to provide regular sleeping quarters for these animals out of doors and prevent flea breeding by methods suggested in the following paragraph. Stray cats and dogs should not be encouraged about the premises. In towns and cities the enforcement of the dog-tax law and the destruction of all untagged animals will tend greatly to reduce house infestations. It is also desirable to keep different kinds of animals which are subject to flea infestation separated, and care should be exercised that infested animals are not brought to clean premises and that infested poultry are not placed with a clean flock.

DESTRUCTION OF FLEAS IN IMMATURE STAGES.

Following the ridding of infested animals of adult fleas, it is important to destroy the immature ones which are constantly becoming full grown and reinfesting animals and annoying man. In household infestations it is usually found that the breeding takes place in the cracks of floors or beneath carpets or in rooms which are not frequently swept, but which may be visited by pet dogs and cats. The carpets and rugs should be removed, the floors thoroughly swept, and all of the dust thus obtained burned, as it contains many of the eggs and maggots of the fleas. The floor should then be scrubbed with strong soapsuds or sprinkled with gasoline, taking care to avoid having fires about during this procedure. After the floor coverings are thoroughly aired and beaten they may be returned, but it is desirable before putting them down to sprinkle the floor with naphthalene crystals or pyrethrum powder.

In flea-infested regions it is advisable to avoid the use of mattings and carpets. These may be supplanted by rugs or oiled bare floors. This permits frequent sweeping of the floors and makes the destruction of the immature stages easier if an infestation becomes established.

Among other methods for destroying the fleas in houses the following have been tried and recommended: Scatter 5 pounds of flake naphthalene over the floor of an infested room and close tightly the doors and windows for 24 hours. After this time the naphthalene may be swept into another room, and so on, thus making the treatment inexpensive. The free use of alum, both in the powdered form sprinkled over carpets and rugs and by dipping papers in an alum solution and placing them under the rugs, is said to give satisfactory results. The fumigation of houses with sulphur fumes or hydrocyanic-acid gas also accomplishes complete destruction. In addition to killing all of the fleas, rats and mice are destroyed by these last-mentioned methods. In using sulphur the infested building should be closed up tightly and the material used at the rate of 4 pounds to each 1,000 cubic feet of space. If the immature stages have been destroyed by the methods mentioned above, 2 to 3 pounds of sulphur per 1,000 cubic feet of space will be sufficient to destroy the adults. The sulphur is made into a cone shape in a good-sized pan or kettle and placed in a larger pan containing water to avoid danger of fire from the heat generated. A little alcohol is then poured into a depression made in the top of the cone of sulphur, and a match applied. Each room should have a pan of sulphur, and the room should be kept closed about 12 hours. As the gas generated corrodes metals and injures plants, it is necessary to remove metal objects and potted plants before fumigating. It is not advisable for anyone to undertake the use of hydrocyanic-acid gas without obtaining the complete directions for its employment as outlined in Farmers' Bulletin 699, entitled "Hydrocyanic-Acid Gas Against Household Insects." This gas is very poisonous, but is one of the most satisfactory for destroying all sorts of vermin in buildings.

When house infestations are derived from fleas which breed beneath or around houses the first step is to clean out all the loose material in which fleas may be breeding and burn it, and then to use crude petroleum freely about the breeding places. This may be followed by scattering common salt about and thoroughly wetting it down. The free use of lime on the cleaned areas also apparently destroys many immature fleas. In exceptional cases lawns become infested, and fleas breed out around the roots of the grass. It is impracticable to apply chemicals in such situations, but much may be done to check the breeding by cutting the grass exceedingly short and thus exposing the young fleas to the heat of the sun, which will usually accomplish their destruction. In certain sections it has been found feasible to destroy flea infestations in barns and hog runs by diking the infested areas and pumping water in so as to flood them entirely.

TRAPPING.

Following the treatment of host animals and the thorough cleaning up of the premises, as has been outlined, many of the remaining adult fleas may be caught by the use of traps.

There seems to be some virtue in the use of lights at night for attracting the adult fleas. A small lamp set in a pan of water covered with a film of kerosene may be used for this purpose.

It has been found that a considerable number of fleas may be collected about a room or cellar by allowing an animal such as a guinea pig or cat to be free in the room. The fleas thus concentrated on the animal may be destroyed by the methods mentioned under "The destruction of fleas on cats, dogs, and hogs." In districts where the plague is known to exist and it is desirable to catch the few fleas which may be about the premises, this method is of some value.

ISOLATING AND REPELLING.

It has been determined that the greatest horizontal distance fleas can jump is about 13 inches, and they can not jump more than one-half of this distance vertically. It is therefore possible to prevent them from gaining access to a bed by placing sticky fly paper about 3 inches wide on the floor around the bed, provided fleas are not breeding out under it. By keeping the bedding from reaching near the floor it is also possible to keep fleas out by placing the legs of the bed in a pan of water covered with a film of kerosene.

Many different substances have been advocated as repellents for fleas. Among these may be mentioned such plants as pennyroyal, and boughs and chips of pine. Naphthalene crystals and pyrethrum have also been employed for dusting between the sheets in order to repel the fleas from bedding, and these substances, as well as oil of pennyroyal and oil of tar, may be used about the household to drive out the fleas.

It should be borne in mind that the methods of trapping and repelling just discussed are only secondary to the more important measures of destroying the breeding places and freeing hosts from fleas.

METHODS OF CONTROLLING THE STICKTIGHT OR CHICKEN FLEA.

Many of the suggestions for controlling fleas in the household are applicable to the sticktight flea. As has been pointed out, this species breeds largely in chicken houses and adjacent buildings frequented by the fowls, although dogs and cats may be important sources of infestation.

As a preliminary step it is well to see that the poultry are kept away from other animals as far as possible. Especial care should be exercised to keep dogs and cats from lying about the chicken yards or places frequented by the poultry. All animals, and the poultry as well, should be excluded from beneath houses and barns, as such places are favorable for flea development and difficult to treat if they become infested. These precautions should be followed by a thorough cleaning out of the chicken house and outbuildings frequented by the poultry. All of the material should be hauled to a good distance from the buildings and scattered out. The places where the fleas are thought to be breeding should then be sprinkled with crude oil. One of the most satisfactory methods of preventing breeding is to scatter salt freely about the chicken house and then wet the soil down thoroughly. This species can not thrive in damp places, and if the sprinkling is done two or three times a week no further breeding is possible. If salt is used, due care should be taken to prevent the fowls from devouring it on account of its poisonous qualities.

It is rather difficult to destroy the sticktights on the poultry without injuring the host. It is desirable, however, in the case of heavy infestations to destroy as many of the fleas as possible. This may be accomplished by carefully applying carbolated vaseline to the clusters of fleas on the fowls or greasing them with kerosene and lard—one part kerosene to two parts lard. In all cases care should be taken when applications are made not to get the material on the poultry except on the seat of infestation. It is important that dogs and cats be freed from sticktight fleas. This may be accomplished by washing them in a saponified coal-tar creosote preparation, as has been described, or many of the insects may be killed by greasing the most heavily infested parts with kerosene and lard. Rats sometimes harbor these fleas in considerable numbers, therefore their destruction will aid in the control work as well as do away with another troublesome chicken pest.

The thorough cleansing of poultry houses and runs and the application of crude petroleum will be found to aid in the control of other important enemies of fowls, such as mites and chicken ticks or "blue bugs."

TREATMENT OF FLEABITES.

In regions in the United States where the plague is not known to occur no special concern need be felt regarding fleabites. When feeding, the fleas inject a salivary secretion which tends to produce inflammation at the site of the puncture. Usually the bites result in small inflamed spots, but occasionally, where the pests are very numerous and in cases where individuals are susceptible to the effect

of the bites, more general inflammation may occur, sometimes followed by swelling and occasionally, especially after scratching, by ulceration.

Those who are especially annoyed by the bites will find that various cooling applications will give relief. A 3 per cent solution of carbolic acid in water applied to the bites will be beneficial, and such substances as menthol, camphor, and carbolated vaseline will be found to allay the irritation. Iodine in the form of a tincture, if applied to the bites, will alleviate the irritation, but should not be used by persons afflicted with any form of eczema or applied to the tender skin of young children, as it may stimulate the eczemic eruptions or blister the skin, causing undue annoyance.

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U. S. DEPARTMENT OF AGRICULTURE

FARMERS' BULLETIN No. 684

SQUAB RAISING



PIGEON raising is conducted successfully as a special business, but is better adapted to serve as a side issue on a small scale in towns and cities and on general farms.

A reasonable profit on the investment and labor required can be made by those who give the pigeons careful and regular attention.

There are a number of good breeds of pigeons from which to choose for squab raising, but special care in selecting and acquiring the foundation stock is very essential, as it is difficult for the novice to determine either the age or the sex of pigeons by their appearance.

This bulletin discusses in detail the general management of pigeons for the production of squabs for market.

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SQUAB RAISING

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PIGEONS are kept in all parts of the United States, but most of the large, squab-producing plants are found near the large cities in the Northeastern and Central Western States and on the Pacific coast. Prolific pigeons that produce large squabs are confined in pens on these squab-producing plants. Common pigeons, which are less prolific and produce small squabs, are kept as a side issue on many general farms throughout the country and are usually allowed to fly at will. Better results would be obtained if good, squab-producing breeds of pigeons were kept and confined in pens.

POSSIBILITIES IN THE BUSINESS

Pigeon raising may be conducted successfully as a special business in towns and cities and on general farms, but is better adapted to serve as a side issue on a small scale. The demand for squabs, especially in large cities, is increasing, and squabs are often used in place of game. The prices received are high enough to make squab raising return a fair profit wherever there is a good market. An average annual return, above cost of feed, of from \$2 to \$2.50 a pair of breeders is considered good on successful plants producing market squabs only. Some of the large, successful pigeon farms make a business of selling breeding stock and produce squabs for meat as a side issue only.

Many persons can keep pigeons successfully as a side issue, although it requires constant oversight and careful attention to details. The greatest difficulties which confront the beginner in the raising of pigeons are procuring good breeding stock and finding a good market for the product of a small flock. Pigeons may be a profitable source of income on many general farms if they are properly handled and if a good market can be found for the

squabs. There have been many failures in squab raising, because the profit in the business has been greatly overestimated and because the care of the stock has been regarded as something in which anyone could succeed without training or experience.

BREEDS SUITABLE FOR SQUAB RAISING

There are many breeds of pigeons, but only six are used extensively for producing squabs for meat in this country—King, Carneau, Swiss Mondaine, Homer, Runt, and Hungarian. These breeds make up what is called the utility class of pigeons, and all, with the exception of the Swiss Mondaine, contain several varieties which are used to some extent for squab raising. Only the most popular variety of each breed is described in this bulletin, as the less common varieties have the same type, shape, and size, and differ only in color.



FIGURE 1.—White King (male). One of the most popular squab producers

The best breed to use depends on the market, but the greatest demand is for good-sized squabs which have light-colored skins. The White Kings, Red Carneau, White Swiss Mondaines, and Black Hungarians are good producers of squabs of this type. Many restaurants and hotels prefer a smaller squab, which is cheaper; the Homer is best adapted for this trade. The Runt is the best breed to keep if an extra-large squab is desired.

The small, common pigeon is probably most widely distributed on farms. These pigeons produce

small squabs, frequently of poor quality, and are not so prolific as the improved breeds.

KING

The White King was produced in the United States about 1890 by crossing the white varieties of the Runt, Homer, Maltese, and Duchess. This is a good-sized breed, the old and the young cock weighing 26 and 24 ounces and the old and the young hen 24 and 22 ounces, respectively. It is a very good producer of light-colored squabs, and is one of the most popular breeds to keep for this purpose. The body should be blocky, with broad shoulders and good depth from the back to the keel. The general appearance should be of an upright "cobby" type, as shown in Figure 1. The carriage is upright with the tail just clearing the ground when the bird is standing in its natural position. The head is moderately large, with a round skull.

The plumage of the White King is white throughout and should be tight and close fitting.

The Silver is the only other standard variety of the King breed.

CARNEAU

The Carneau originated in France and was not brought into the United States until about 1900. Although slightly smaller than the King, it is a good-sized bird, the old and the young cock weighing 24 and 23 ounces, and the old and the young hen 23 and 22 ounces, respectively. It is also one of the most popular squab producers in this country, and is an excellent breeder of high-quality squabs. The body is short, compact, and full-breasted, with an upright carriage and moderately short wings and tail, as illustrated in Figure 2. The head is of moderate size, broad between the eyes, and has a gradual, rounding curve over the skull.

The Red Carneau is the most popular variety of this breed for squab production. The surface plumage should be of a deep chestnut red throughout, with the color penetrating to some extent into the undercolor.

Other standard varieties of the Carneau are the Yellow, Black, White, Rosewing Red, and Rosewing Yellow, but the last three are not common.



FIGURE 2.—Red Carneau (male), another popular squab producer

SWISS MONDAINE



FIGURE 3.—White Swiss Mondaïne. This breed is rapidly becoming popular for squab production

The Swiss Mondaïne was developed in the United States by crossing the White Runt with some other large, white pigeon. The term "Swiss," as applied to the breed, is based on unverified reports of importations from Switzerland, but there is no pigeon of this type in that country. A somewhat similar breed called the French Mondain, of which there are several kinds, is bred in France but kept to only a small extent in the United States.

The Swiss Mondaïne is slightly larger than the King. The legs are slightly longer and the body

and neck are longer and more slender. The head is of medium size and is full in front. This breed shows great length in every part, which gives it the long, sweeping appearance shown in Figure 3. It is an excellent squab-producing breed, the old and the young cock weighing 27 and 24 ounces, respectively, and the old and the young hen weighing 24 and 21 ounces. This breed is neither so well known nor so widely distributed as the King or the Carneau.

The plumage of the White Swiss Mondaine, which is the only standard variety of the breed, is white in every section. It is a close-feathered breed with clean legs. The flight feathers of the wing are very long, but the wing should be carried up tightly to the body.

HOMER

The Homer (fig. 4) is not usually classed as one of the utility breeds, but it is the oldest breed of pigeons in this country and has been used very extensively for squab production, the birds used originally for this purpose having been of flying Homer breeding. The Homer is primarily a flying pigeon kept for racing purposes, and derives its name from the fact that it has a remarkable faculty for returning to its home. Because of this trait it is necessary to keep this breed confined if the pigeons have been purchased.

The Homer is the most prolific breeder and the best feeder of all the breeds and is a very desirable breed to keep if a medium-sized rather than a large squab is desired. It may often be kept to advantage with one of the larger breeds. The bird should be of medium size and have a neat, trim, compact appearance. The breast and back should be broad and well muscled.



FIGURE 4.—Homer (male). A very good producer of small squabs

Three distinct lines of Homers are bred, namely, the flying, the exhibition, and the show. These three kinds differ materially in shape, size, and head points. Homers used for squab production have been selected and bred from either the flying or the exhibition lines, as the show Homer is not adapted for producing market squabs. Little attention has been

given to color in breeding the Homer either for squab production or for racing, but the Blue, Blue Checker, and Black Checker are the most common varieties. The color of the Blue variety is an even shade of light grayish blue in all sections except the head, neck, tail, and ends of the wings, which are much darker. The Blue Checker variety has a ground color of light grayish blue, and the back and wings are evenly checkered with black. Size is very important in market squabs, and only large-sized Homers are suitable for squab production.

RUNT

The Runt in this country is said to be descended from the Spanish common pigeon. As it is the largest of the breeds kept here its name is rather misleading. The Runt is characterized by a very large body, giving an appearance of massiveness and great strength, as shown in Figure 5. The head is large and broad between the eyes, and the top of the skull is oval. The body is blocky, the breast broad and deep, and the back broad. The Runts are considerably larger than the other squab breeds, the old cock weighing 3 pounds, the old hen and the young cock each $2\frac{3}{4}$ pounds, and the young hen $2\frac{1}{2}$ pounds. The Runt lacks the upright, "cobby" type of the King,

the breast being carried only slightly above horizontal, with the tips of the wings resting on the tail.

Runts are kept to some extent for squab production, but are usually not so good, either as breeders or as feeders, as the smaller breeds. They are sometimes used to cross with the small breeds, but as a rule better results are obtained by keeping the breeds pure. Runts are frequently kept in pairs in individual pens, as they often fight and injure one another when kept even in moderate-sized flocks.

The White Runt is by far the most popular variety of this breed for squab production, while the six other standard varieties, the Blue, Black, Red, Yellow, Silver, and Dun, are only occasionally used for this purpose. The plumage of the White Runt should be pure white in all sections. The feathers should be tight fitting and the wings and tail of moderate length only. This breed, as well as all squab producers, should have shanks and toes free from feathers.



FIGURE 5.—White Runt (male). The largest variety of pigeon but usually only a fair producer

HUNGARIAN

The Hungarian pigeon, which was introduced from Hungary, differs very materially in type from the other breeds commonly kept for squab production. It has a short, compact, solid body, a long neck, high tail, and long legs, as shown in Figure 6. The standard weights are 26 ounces for the old cock, 24 ounces for the old hen and the young cock, and 22 ounces for the young hen. Care should be taken to avoid breeding the birds which are very high on their legs, as the reproduction of that type will reduce the heavy, square body so essential in the production of good market squabs. The Hungarian, although a good squab producer, is not kept so extensively for this purpose as the other breeds discussed, more attention having been given to selecting the breed for standard color, making it a very attractive pigeon for exhibition.



FIGURE 6.—Black Hungarian (male). A good squab producer but bred more for exhibition

The Black Hungarian, shown in Figure 6, is the most widely distributed variety of this breed, but no one variety is especially outstanding in numbers, as is the case with the other squab-producing breeds. This variety has almost as much white as black in its sur-

face color, but the black markings are much more prominent. The black is of a deep, even shade, with a white stripe resembling a tape marking extending over the crown of the head, down the back of the neck, widening as it goes, thus forming a triangle with the narrow, pointed vertex at the back of the neck. The white extends in a narrow stripe around the front of each wing and comes together from both sides in an even curve, where it is merged into the white of the lower part of the breast, legs, and thighs, meeting over the rump. The breast is covered with a large, black, pear-shaped bib which extends up to the head. The tail and wings are black except for 8 or 10 of the long flight feathers in each wing, which are white.

SELECTING BREEDERS

Good breeding stock is one of the prime essentials of success in squab raising. It is advisable to buy pigeons from reliable breeders and, if possible, from those who guarantee their product. Many failures in squab raising have been due to poor stock, because the prospective producer either bought old pigeons past their period of usefulness or obtained a surplus of male birds. It is difficult to determine by casual observation the age and the sex of pigeons, and this makes it difficult for the buyer to determine the value of the stock.

Constant and careful culling must be followed to make squab production profitable. This requires that the nests should be examined frequently and careful records kept of the squabs. The medium-sized breeds of pigeons which do not raise at least six pairs of squabs annually to market age should be either culled or remated. There is a great difference in the value of pigeons as squab producers, even when of the same variety, making it advisable to select the birds individually for their vigor and productiveness, for the quality, number, and size of their squabs, and for their ability properly to feed and rear their offspring. Dark-colored skin, legs, or beak indicates poor quality of flesh, and should be avoided by selecting birds for breeding which have white or pinkish-white skin and light-colored legs.

Young pigeons, less than a year old, which have mated and begun to breed, are commonly purchased to begin pigeon keeping. Pigeons are most valuable as squab producers when from 2 to 5 years old, although many breed until they are about 8 years old. Homers will breed at 6 months of age but do best if not mated until they are 7 months old. The larger breeds, such as the King, breed at from 7 to 8 months but give best results if mated at 9 months of age. The best breeding results are obtained if the young birds are not allowed to breed until they are well matured.

Squabs hatched in April, May, and June make the best breeders, while their market value as squabs is comparatively low at that time of the year. The first four or five sets of squabs produced by young pairs should be marketed and only those from older birds saved for breeding. Those which are to be saved for breeding should be banded as soon as their feet are large enough to hold the bands, usually when from 7 to 10 days old, so that a record of their breeding can be kept. Numbered, seamless bands, which are

slipped over the squabs' feet, are used to keep pedigree records. The young pigeons are commonly removed from the breeding pen and put into a pen by themselves after they are able to fly about and pick up their own feed. A catching net or bag made of large-mesh cotton netting, with the mouth or top about 18 inches in diameter, is very useful for catching pigeons.

MATING

Pigeons mate in pairs and usually remain with their mates throughout life, although the mating may be changed if desired. The presence of unmated pigeons (especially males) in the pigeon loft is a source of much trouble and usually prevents profitable results; therefore it is very essential that only mated birds be kept in the breeding pens.

It is difficult for the novice to distinguish sex in pigeons, as it can be determined only by the general appearance, walk, carriage, and actions of the breeders. The male is larger and coarser than the female, especially in the head and neck, and is much more aggressive. The male struts about, making a cooing noise, and drags his tail on the ground; but the female rarely struts or cooes and she holds her body more horizontally than the male. This strutting of the male tends to make the ends of his tail feathers rough. A very aggressive young male may be used in the pen as a decoy to drive the females so that the latter may be separated from the flock. The pelvic bones, which are close together and hard in the male, are spread apart in the female after she has begun to lay, and the female then has a tendency to waddle when walking.

Two methods of mating are used, natural and forced, and either will give good results. Unmated males and females are kept in a pen in natural mating and allowed to select their own mates, which is usually indicated by the male's billing with and driving the female. If properly mated the pair will commence to build their nest and will be found together at night, while unmated birds usually remain alone. Newly mated pigeons may be allowed to build a nest and lay eggs in the mating pen to be sure that they are well mated.

Forced matings may be made if the sex of the pigeons is known. A male and a female which are to be mated are confined in a mating coop. The pigeons should be kept in this mating coop from 6 to 14 days until they become settled. They are removed to the breeding pen as soon as they appear to be properly mated. The nest boxes may be closed and used for mating coops by placing wire frames across the fronts. (Fig. 7.)

Careful selection and mating of breeding stock and constant culling are essential in building up a productive flock of squab producers. Matings should be made to increase the vigor and prolificacy of the stock and to improve the size and color of the squabs. Mating, production, and rearing records should be kept of the pigeons and all unprofitable birds culled. Old pigeons mated with young birds often give good results in breeding, making it advisable sometimes to break up and change a mating as a pair gets old and production decreases. If a breeding pigeon dies, its mate should be removed from the pen and a new mating made. Pairs which produce dark-colored or small squabs should be culled or remated.

Continued close inbreeding is not a desirable practice for the average squab raiser. Inbreeding, however, tends to fix good as well as undesirable characters, making it a means of either great improvement or marked deterioration, depending on how carefully the matings are made. If the pigeons are allowed to mate at will and a pair from the same nest mate together, it is usually advisable to separate and remate such closely related birds.

A simple but accurate system of records should be kept for each pen, showing the band numbers of each pair. In addition to the seamless bands put on when they were squabs the breeding males are usually banded on the right leg and the females on the left leg, so that the sex of the birds in the breeding pen can be readily seen. The use of large, colored, numbered bands makes it easier to keep these records. The nests are numbered and a record kept of the nest occupied by each pair. The fronts of all unoccupied nests should be kept closed so that there is only one double nest for each mated pair.

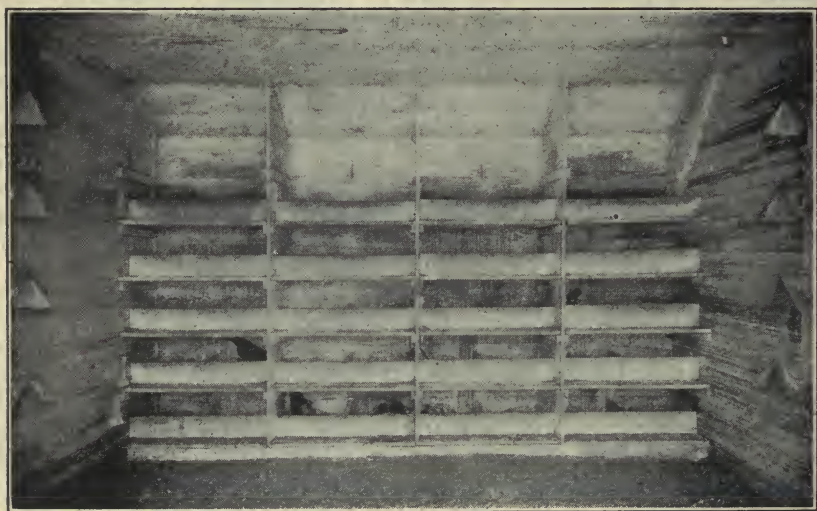


FIGURE 7.—Double nests which can be used as mating coops by placing wire frames across the fronts

HATCHING AND REARING SQUABS

The period of incubation of pigeon eggs is about 17 days. The hen pigeon usually lays one egg, skips a day, and then lays again. If more than two eggs are laid it is advisable to remove the extra ones, as a pair of pigeons can raise only two good squabs at one time. Both the male and the female pigeon sit on the eggs, the male usually sitting from about 8 a. m. until 3 or 4 p. m., while the female stays on the nest the rest of the time. Pigeon eggs are usually fertile if the pigeons are healthy and properly fed. One squab frequently hatches first; and if there are several nests in which one squab outgrows its mate, it may be advisable to sort the squabs in the nests, making the pairs as nearly uniform as possible in size and age. While squabs are in the nest males usually grow faster and are noticeably larger than females. Some birds do not feed

their squabs well, and it is sometimes necessary to transfer such young to other breeders which have only one squab each; but squabs should not be moved any more than is absolutely necessary.

Squabs are reared and fed by both of the parent birds on a thick, creamy mixture called pigeon milk, produced in the crops of the pigeons. Pigeons usually feed their squabs shortly after they themselves are fed and should not be disturbed at that time, thus making it advisable to water them before they are fed. Care should always be taken not to frighten pigeons, and squabs should not be disturbed any more than is necessary. If the parent birds die, the squabs may be removed to a nest where there is only one squab, or they may be fed artificially, although this process takes considerable time.

FEEDING

The feeding of pigeons differs radically from that of poultry in that pigeons are not fed any mash or green feed and they feed their own young. Pigeons should be fed a ration of whole grains and be provided with a constant supply of fresh water and grit. A good mixture of staple grains may be made of four parts, by weight, of small, whole corn, and three parts each of kafir and field or Canada peas, and one part each of hard, red wheat and millet or hempseed. Hempseed should be included in the ration during the molting period. The proportion of corn in the ration may be reduced somewhat during warm weather and increased in winter. Argentine corn is small and is thoroughly dried, making it desirable for pigeons, but any well-dried corn may be used.

Other feeds which may be used with good results in feeding pigeons are maple peas (a foreign product similar to field peas), peanut kernels and garden peas in place of Canada peas, Egyptian corn or milo for kafir, and hempseed or flaxseed for millet, while a small quantity of rice, rape, canary, vetch, and chopped sunflower seed may be fed for variety. Canada peas and peanuts are expensive, but some feed of this kind high in protein is necessary for profitable squab production. Cowpeas are sometimes used to replace Canada peas, but do not give so good results. Soybeans are not relished by pigeons, and contain less vitamin A than Canada peas.

Millet, flaxseed, and hempseed have a rather high vitamin content, and peas or peanuts may also help to supply this need. Yellow corn, because of its vitamin content, is probably a better feed than white corn for pigeons which are confined. A stimulating seed, such as vetch, is sometimes fed as a tonic to breeding birds during the molting period.

A variety of good, hard, thoroughly dried grain is essential to success. Grains which are in poor condition should not be fed to pigeons. New, soft grains, especially wheat and corn, should never be fed to pigeons, as they will cause bad results in the flock, particularly among the squabs. The smaller kernels of whole corn, sold as pigeon corn, are used for pigeons, and flint corn is especially desired. Cracked corn should not be used. Hard, red wheat is considered better than white wheat for pigeons, while some breeders of pigeons prefer a ration without wheat. Only the best grades of wheat should be used.

Commercial mixed pigeon feeds are used extensively in feeding pigeons, especially where only a small flock is kept. The quality of these feeds is usually good, and it is easier to buy them for a small flock than to mix the ration at home, on account of the number of grains used. Dealers often handle two or three grades of feeds, but it usually pays to get the best quality, which contains a considerable quantity of peas, while the cheaper grades have few if any peas in them. The fat, crude protein, carbohydrate, and fiber analyses of these commercial feeds are marked on the bags.

Table 1 gives the composition of the grains most commonly used in feeding pigeons. Peas and peanuts contain a large percentage of protein, which is the most valuable and most expensive constituent of a pigeon feed. The ration mentioned, consisting of four parts, by weight, of small, whole corn and three parts each of kafir and field peas, and one part each of hard, red wheat and millet seed, contains about 13.6 per cent crude protein, 70.5 per cent carbohydrates, 3.4 per cent crude fiber, and 3 per cent fat.

TABLE 1.—Average composition of pigeon feeds

Feed	Moisture	Ash	Crude protein	Carbohydrates		Fat or ether extract
				Crude fiber	Nitrogen-free extract	
	<i>Per cent</i>	<i>Per cent</i>	<i>Per cent</i>	<i>Per cent</i>	<i>Per cent</i>	<i>Per cent</i>
Corn.....	12.9	1.3	9.3	1.9	70.3	4.
Cowpeas.....	9.8	3.6	23.8	4.3	57.1	1.
Field peas (Canada).....	9.2	3.4	22.9	5.6	57.8	1.
Flaxseed.....	9.2	4.3	22.6	7.1	23.2	33.
Garden peas.....	11.8	3.0	25.6	4.4	53.6	1.
Hempseed.....	8.0	2.0	10.0	14.0	45.0	21.
Kafir.....	9.4	1.6	11.1	2.1	72.6	3.
Millet.....	10.8	3.6	12.1	8.4	61.0	4.
Milo.....	10.7	2.8	10.7	2.4	70.5	2.
Peanut kernels.....	5.5	2.3	30.2	2.8	11.6	47.
Rapeseed.....	14.0	3.9	19.4	7.8	16.4	38.
Rice (polished).....	12.3	.5	7.4	.4	79.0	.
Soybeans.....	6.4	4.8	39.1	5.2	25.8	18.
Sunflower seed.....	6.9	3.1	16.1	27.9	21.3	24.
Wheat.....	10.6	1.8	12.3	2.4	71.1	1.

The grain is usually kept before the birds in hoppers but may be fed on the floor of the pen or in troughs. It is not advisable to feed the grain on the ground, especially on heavy soil, where it may get wet and moldy. Unless the floor is kept clean it is better to feed the grain in troughs than on the floor. The troughs should be made so that the pigeons will not roost on them and soil the feed with their droppings. Hoppers in which feed is kept before the pigeons are sometimes used, but may attract rats. Troughs and open hoppers should be fitted with wires or slats about 2 inches apart, so that the pigeons can not waste the feed by throwing it out on the floor.

If the grain is not kept in hoppers the pigeons should be fed regularly twice daily, giving from $1\frac{3}{4}$ to $2\frac{1}{2}$ quarts or $2\frac{1}{4}$ to $3\frac{1}{4}$ pounds of grain at each feeding to 20 pairs of pigeons, depending on the size of the pigeons and the number of squabs in the nests. It is very essential that the pigeons have a plentiful supply of grain while they

are rearing squabs. The feeder must regulate the quantity of grain according to the appetite of the birds, giving them all they will clean up in one hour. A pair of Homers will eat about 80 pounds and Kings about 110 pounds of feed in a year, which, in 1929, cost, respectively, \$2.56 and \$3.52 a year at \$3.20 for 100 pounds. Prices of grains in 1929 were about the same as in 1927 and 1928.

Clean drinking water, fine grit, oyster shell, and charcoal should always be kept before the pigeons. Salt is essential but should be fed in either a mineral mixture or in brick form, such as rock salt. Commercial mineral mixtures containing salt, medium limestone grit, oyster shell, charcoal, and various minerals are used by many pigeon raisers. A good mixture for this purpose may be made of 40 pounds of medium oyster shell, 34 pounds of medium limestone grit, 10



FIGURE 8.—Shed-roof pigeon house with partly open front. Attached fly contains a concrete bathing and drinking basin supplied with running water

pounds of charcoal, 5 pounds of ground bone, 5 pounds of ground limestone, 5 pounds of fine salt, and 1 pound of Venetian red. Dissolve the salt in a gallon of hot water before mixing it with the other ingredients. Such mixtures are relished by the pigeons and help to keep them in good breeding and feeding condition.

MANURE

Dry pigeon manure may be sold to market gardeners or florists in some localities at a good price, but it is more commonly used at home as a fertilizer. As it is rather rich it has considerable value as a fertilizer and should be mixed with dry dirt or some filling material before it is used. It used to be sold to tanners, but artificial preparations have largely replaced manure for tanning.

PIGEON HOUSES AND EQUIPMENT

The important considerations in building pigeon houses are fresh air, sunlight, economy of labor, material, and space enough to keep the pigeons comfortable. Fresh air is essential in a pigeon house. Pigeons will do well in a cold house provided it is well ventilated. Dryness is also necessary. Not only should the building be tight to keep rain out, but the moisture from the pigeons and from the nests of squabs within the house must be carried off by ventilation. The more sunlight in the house the better, as it helps to dry out the moisture and also makes the building more sanitary. These houses should face the south, so that they will have the greatest amount of direct sunlight in the front. As labor is a big item, the arrangement of the house for convenience in performing the necessary work adds to the chances of success.

The shed-roof type of house shown in Figure 8 is one of the simplest and best types to use for market-squab production. The house is 16 feet deep, 6 feet high in the rear, and 8 feet high in front.



FIGURE 9.—Hip-roof pigeon house (used in New Jersey)

The pens are 9 by 12 feet, with a 4-foot alleyway in the back part running the entire length of the house. The alley is 4 feet wide to provide space for feed hoppers and boxes for grit, shell, and tobacco stems, for which devices are built into the alley partition, so that they can be filled without going into the pens. (Fig. 12.) An alley 3 feet wide is large enough for all other purposes. The pens are arranged to open into the alley, so that the pigeons will not be disturbed any more than is absolutely necessary. A separate alleyway is always desirable in a house which contains more than four pens.

Other styles of houses and outside yards or "flies" are shown in Figures 9 and 10. Houses of various styles may be used for pigeons, and in many cases where only a few are kept available buildings, such as lofts of barns and vacant poultry houses, can be fitted up at small cost. Details of the construction of houses are given in Farmers' Bulletin 1554, Poultry Houses and Fixtures. The same kind of lumber and style of construction are used for pigeon as for poultry houses, except that pigeon houses must be well built and

tightly constructed to make the pens comfortable during cold weather.

Construction costs are affected by many local factors, so that only a very rough estimate of the probable outlay for construction can be given. The estimated cost for the 3-year period 1927-1929 was from \$2 to \$3 for each pair of breeders housed. The cost for materials alone would be about two-thirds of the total construction cost.

More open and less expensive pigeon houses may be built in mild than in cold climates, but the house must be comfortable in cold weather. The building should be tightly constructed on the north, west, and east sides to prevent drafts, and the opening in the south side should be arranged so that the sunshine can thoroughly dry out the pen. The fronts shown in Figure 8, which are adapted for conditions around Washington, D. C., and points south, are never closed. Figure 9 shows a style of front adapted for sections farther north. The openings in both of the houses are protected to keep rain from beating into the pen.



FIGURE 10.—Pigeon house and fly. Note bath pan against fence

Artificial heat is used to some extent in pigeon houses and heat enough to keep the house dry and comfortable (about 40° F.) tends to increase squab production during the winter months. Good ventilation must also be provided. If double or insulated walls are built, they must be arranged so as not to harbor rats.

The house may be made any length desired, the best length being governed by the number of pigeons to be housed and by the slope of the land.

The necessary floor space to allow for each pair varies from $2\frac{1}{2}$ to $3\frac{1}{4}$ square feet, according to the size of the pigeons. More floor space per pair is required in small than in large pens. Pens 8 by 12 feet will accommodate 30 pairs of large pigeons, or 40 pairs of Homers, which is as many as should be kept together in one pen.

It is very difficult to keep a record of the breeding if more pairs than this are kept together. A separate pen for each pair of pigeons is sometimes made for Runts, as that breed does not do so well where any considerable number of breeders are kept together.

FLOORS AND FLIES

The floors of pigeon houses should be constructed so that they can be kept free from rats easily. This may be accomplished by building the house from 18 to 30 inches above the ground, using board floors, and boarding up the space between the ground and the floor, but leaving small doors or openings for ventilation and so that cats and dogs can get under the house. Wooden floors so constructed should be double, with building paper between the layers, except in the southern part of the United States. Concrete makes a very good floor for a pigeon house, as it will keep rats out, but it must be well covered with sand or straw.

Nearly all pigeons kept for squab production are confined by the use of an outside fly or yard covered with wire, which is built on the

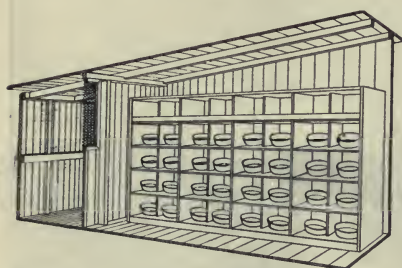


FIGURE 11.—Interior of pigeon pen, with nests arranged in pairs. The upper tier shows the use of a retaining strip in place of individual nest bowls

south side of the house. This fly is usually made from 6 to 8 feet high, 15 to 20 feet long, and of the same width as the pen. The wire may be buried in the ground to keep rats out of the fly. A few pigeonholes about 8 inches in diameter are made in the upper part of the front of the pen, as shown in Figure 9. Larger openings, oblong in shape, are sometimes used. No holes are needed in the house shown in Figure 8, as the front of the house is never closed. Boards 6 inches wide on which the

pigeons can light should be placed at the bottom of all pigeonholes on both the outside and inside of the house. Roosting boards about 4 inches wide are placed only at the end and on the sides of the fly as shown in the accompanying illustrations. (Figs. 8, 9, and 10.) These boards should be at least 4 inches from the outside wire and should not be placed where they will prevent the pigeons from flying freely in the yards. Two-inch mesh wire is commonly used to cover the fly, but 1 inch mesh wire is preferable in localities where sparrows are abundant.

INTERIOR FIXTURES

The interior fittings should consist of a double nest for each pair of breeders, nest bowls, and miscellaneous equipment, such as feed hoppers and a receptacle for tobacco stems. All this equipment should be as simple as possible and easy to clean. Double nests are necessary because the pigeons frequently begin to build another nest when their squabs are only 2 weeks old. There should be only as many double units as there are mated pairs, and any additional nests in the pens should be kept closed. Portable wire fronts are used to close these extra nests and are also used to confine pigeons which are mating when the nests are used as mating coops.

Nest compartments should be 12 inches high, 16 inches deep, and 24 inches wide, divided into two parts, as shown in Figure 11. Double nests for very large breeds, such as the Runt, should be 2 inches deeper and 4 inches wider than for the medium-sized breeds. The partition in each double nest is set back 4 inches from the front of the nest to provide a runway for the pigeons. This allows each pair to control its own nest but tends to prevent them from fighting with neighboring pairs. This type of nest provides room for both roosting and nesting so that no separate roosts have to be provided on the walls. The floors of the nests should be arranged so that they are portable and may be easily cleaned. The nests are usually built in tiers against the side walls of the pen, extending from the floor to 6 or 7 feet high. (Figs. 7 and 11.) Two nest bowls are usually provided for each pair of breeders and help to keep the nests sanitary. Such bowls are made of earthenware, wood, or fiber. A convenient size is from 3 to 4 inches deep and 8 to 10 inches in diameter. Nest pans are not used at all in some pigeon plants, in which case the nesting material is retained by the strip in the front of the nests, as shown in Figure 7.

Only a small quantity of nesting material is kept in each pen, as the pigeons are apt to waste much of it if there is an abundant supply. Straw, coarse hay, and tobacco stems are used for this purpose. This nesting material may be kept in a slatted crate from which the pigeons may collect the pieces and build their own nests. A thin layer of sand on the floor makes it easier to keep the pen clean, or the floor may be lightly covered with straw or sawdust.

Hoppers and feed troughs should be of good size, and the hoppers should be constructed so that the pigeons can not waste the grain easily by throwing it out on the floor. Drinking fountains, hoppers for feed, grit, and shell, and boxes for the nesting material should be arranged so that they can be readily handled from the alley. They are often built into the partition which separates the alley from the pens. (Fig. 12.) Drinking vessels should be arranged so that the pigeons can not bathe in them. Large pans covered with wire, or fountains as shown in Figure 13, are best adapted for the purpose. A galvanized-iron pan from 3 to 4 inches deep and from 15 to 20 inches in diameter makes a good bath pan. Water for bathing should be provided daily in the yard, except during stormy, cold weather. These bath pans are usually filled in the morning and



FIGURE 12.—Alley in rear of pigeon house, showing arrangement of feed hoppers

emptied about one hour later. They are generally used only on sunny days in winter. It is very important that the bathing pans be kept clean, as the pigeons will drink out of them. If the pigeons drink filthy water its use may seriously affect the health and growth of the squabs. An outside watering and bathing basin which is supplied with running water makes an ideal arrangement.



FIGURE 13.—Above: Water founts with bath pan in center. Below: Feed hopper with a revolving rod on top. This hopper may be placed away from the wall so that the pigeons can eat from either side

MARKETING THE SQUABS

The production of squabs from each pair of breeders varies from 1 or 2 to as high as 10 or 11 pairs a year, but an average of 6 or 7 pairs of the large breeds fit for market, and 7 or 8 pairs of the smaller breeds is a fair average. By careful selection and culling, the yearly average may be increased 1 or 2 pairs. Squabs usually sell at the highest prices per pound during cold weather, as pigeons do not breed so freely then as in spring. The quality of winter squabs is not so good as that of spring squabs, and those produced

in the winter do not usually grow so well as those produced in spring and summer.

The price paid for dressed squabs varies with their size and quality, with the season of the year, and with the market location. The average monthly price per pound on dressed squabs weighing 11 pounds to the dozen, which is a fair average weight for good squab plants, was as follows, according to the wholesale quotation in New York for the 3-year period 1927 to 1929: January and February, 80 cents; March, April, and May, 65 cents; June through September, 55 cents; October, 60 cents; November and December, 70 cents. Prices in 1929 were lower than in either 1928 or 1927. Squab weights vary according to the breed and are also affected by feeding and by the selection of the breeders. Homer squabs usually weigh from 8 to 11 pounds to the dozen; Carneau, 10 to 13 pounds; Kings, 11 to 14 pounds, and Swiss Mondaines, 14 to 17 pounds. Small and dark-skinned squabs bring lower and extra large squabs slightly higher prices than these quotations.



FIGURE 14.—Squabs 24 hours old



FIGURE 15.—Squabs only 7 days old but several times larger than when hatched

Squabs are fed by the parent birds until they are marketed. They grow very rapidly and attain more than two-thirds of their mature weight in four weeks. Squabs at various ages are shown in Figures 14, 15, 16, 17, and on the title page.

Squabs are marketed at from 3 to 4 weeks of age, before they are able to leave their nest. They must be sold at about this age, as the period during which they are ready for market rarely exceeds one week. Squabs are in good market condition when fully feathered under the wings, which is usually about the time they begin to leave their nests, and if not marketed at that time they soon lose their baby fat, while their flesh begins to get hard and loses its especially desirable character. (Figs. 18 and 19.) It is said that the flesh and juices of the squab at about 4 weeks of age are especially nourishing.

Market squabs should be collected from the nests early in the morning, before the pigeons are fed, at which time the squabs' crops are usually empty. They are usually killed in the same manner as poultry, by opening the mouth and cutting the jugular vein in the

throat just below the base of the skull, after which the brain is usually pierced. In sticking, the squabs are hung by their legs on nails or hooks, with their wings double locked. After they are stuck the feathers are plucked immediately, using a dull knife for the pinfeathers. The appearance of the dressed squabs can be improved by singeing the flesh over an alcohol burner. If the crop contains any feed it should be cut open and thoroughly washed. After killing and picking, the squabs are cooled by placing them in cold water or by hanging them in a cool place.

Dressed squabs should be washed, cleaned, and graded according to size and quality, as dark-colored and small squabs tend to lower the price paid for an entire shipment of mixed squabs. For shipment by express they are packed in cracked ice in a tub or box, with alternate layers of ice and squabs. The words "Dressed squabs" and the weight of the shipment before the ice is added should be marked on the box, as express companies allow 25 per cent off the gross weight for the ice packing. The box or tub should



FIGURE 16.—Two weeks old and still growing rapidly



FIGURE 17.—Squabs 3 weeks old. (Squabs 4 weeks old are shown on cover page)

have holes in it for drainage. Local express shipments may sometimes be made without ice if the squabs are thoroughly cooled before shipment. Many squab plants are situated near enough to their market so that the producers can deliver the squabs direct, thus eliminating the express shipments and ice packing.

The express charges on small shipments of squabs reduce the profit materially, and it is necessary to have a good-sized flock to furnish more than a dozen birds for market at one time. A local market that will take any number of squabs is a great aid to the small producer. It usually pays best to build up a small flock until it is large enough to make good-sized shipments unless there is a good local market. This, however, requires constant expense without any return for some time.

SANITATION

The pens and yards where pigeons are confined must be kept clean. There is very little chance of making squab production profitable unless the pigeons can be kept comparatively free from diseases and insect parasites. Diseases and parasites should not be a serious

matter in squab raising, however, if healthy breeding stock is obtained and if houses and yards are kept clean and careful attention is given to the birds.

The stock should be carefully watched and any sick birds removed from the breeding pens. If one bird of a pair is sick the mate should also be removed.

The house should be kept dry, clean, well ventilated, and free from drafts. The floor should be covered with 1 inch of sand or gravel, and the manure deposited on top of the sand should be raked off frequently. The outside yards should be kept clean either by scraping the surface and adding fresh sand or gravel or by turning the soil over. The outside yard can be built with a concrete or wire floor, which is much more sanitary than one of dirt.



FIGURE 18.—Squab showing pinfeathers on underside of wing; not quite old enough for market



FIGURE 19.—Squab 4 weeks old; ready for market and fully feathered under the wing

The nests, nest boxes, and pens should be kept clean, but the individual nest bowls should not be cleaned out while they contain eggs or squabs. Each spring the entire pen should be thoroughly cleaned out; the cleaning should include scraping the floor and nests and washing them with lye water. A disinfectant or whitewash should be freely sprayed over the entire interior of the pen. A compound solution of cresol makes a good disinfectant, using 1 pint of this to 12 quarts of water. The nest boxes and perches should be examined for mites, especially in hot weather, and sprayed with crude oil thinned with kerosene or with a wood preservative containing anthracene oil, if mites are present. If the pigeons have many lice on their bodies and wings they should be treated with sodium fluoride, either by dusting by the pinch method or by dipping in a solution. The

treatment of lice and mites is discussed in Farmers' Bulletin 801, Mites and Lice on Poultry. The nests or nest pans should be cleaned and the nesting material removed as soon as the squabs are marketed or leave the nest.

Pigeons are subject to many of the diseases which affect poultry and may be treated in the same manner. Poultry diseases are discussed in Farmers' Bulletin 1337, Diseases of Poultry. Canker in the mouth and throat, and tuberculosis, which results in the birds' "going light," are the two diseases most common among pigeons. They are contagious and their spread is favored by insanitary conditions, foul drinking or bathing water, and poor quality or kinds of feeds. The unfavorable conditions should be removed at once, and potassium permanganate may be added to the drinking water, using enough powder to give the water a light wine color.

CAUSES OF THE DEATH OF SQUABS

The loss of squabs by death may result from a number of causes which have been discussed somewhat throughout this bulletin. The cause of mortality in each case must be found and removed if profitable results are to be expected. Some of the common causes are extra males or unmated pigeons, which are constant causes of fighting in the breeding pens, coccidiosis in the breeding stock, rats in the house, and lack of vitality because of carelessness in breeding and selecting the stock. Unthrifty squabs may be caused by the use of dirty water, poor quality of feed, lack of proper feed, and by filthy conditions in the pen. Good results can be obtained only when the loft contains selected, strong, healthy, mated breeders, when the quarters are kept clean, and when good feed is properly fed.

SUMMARY

Success in raising squabs requires careful consideration of certain factors.

The breeders should be healthy, vigorous, and properly mated. Good-quality foundation stock is very essential to success.

Only prolific breeders which are also good feeders should be kept.

A variety of good-quality, hard grains, including peas, should be fed. Grains that are thoroughly dry, and small, whole corn should be used.

The pigeon pen should be dry, well ventilated, and kept free of rats and mice. A double nest should be provided for each pair of breeders.

Keep fresh drinking water, protected from dirt, before the pigeons, and provide a separate pan of water for bathing.

The squabs must be marketed as soon as they are feathered under the wings, which is about the time they are able to get out of their nests.

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Contribution from the Bureau of Plant Industry, Wm. A. Taylor, Chief.

THE NATIVE PERSIMMON.

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INTRODUCTION.

The persimmon seems to have been the first native American fruit to be described and praised by the early explorers. De Soto learned its food value in 1539, and in 1557 published an account of it at Evora, Portugal. The following year, 1558, Jan de Laet described the persimmon in his work on Virginia. John Smith's narrative of the settlements and resources of the New World, written during the first years of the seventeenth century, included a long discussion of the persimmon. In his reference to this fruit, where he says "If it be not ripe, it will draw a man's mouth awrie with much torment," he so well characterizes the puckering, astringent effect of the tannin contained in the immature fruit that no other comment is necessary. The persimmon tree has received more criticism, both adverse and favorable, than almost any other known species. Those who have discussed the food value of the fruit, from the earliest chroniclers to recent writers, have prophesied that the tree would soon be accorded a place in our gardens and orchards. Those people, on the other hand, who have been acquainted only with the immature fruit or with the young sprouts in cultivated fields have had nothing to say

NOTE.—This is a general bulletin, intended for those to whom knowledge of the production, preparation, and uses of the native persimmon is of value.

in its favor and have bent their energies toward its destruction rather than its propagation and cultivation.

There are several factors which are responsible for the slow progress of persimmon development in this country. One reason for the neglect of this fruit seems to be the erroneous yet oft-repeated statement that persimmons are unfit to eat until they have either been touched by frost or frozen. Although this statement has been corrected by nearly every one who has studied the subject, nevertheless throughout the regions where persimmons are grown many of the best fruits are lost each year because they ripen and fall before frost or before they are supposed to be edible. The truth of the matter is that freezing is as detrimental to the quality of persimmons as the quality of any other fruit. If persimmons are not edible and free from astringency before frost, it is because the variety is a late one and the fruit has not yet matured.

The development of the persimmon, whether for orchard or ornamental purposes, has been retarded by the difficulty encountered in propagating and transplanting it. One grower has characterized it as the only tree that he could not kill in his cultivated fields and the only one that he could not make live in his garden. Failure in transplanting is usually due to a lack of knowledge concerning the characteristic root development of the persimmon. Under natural conditions, the roots penetrate much deeper into the soil than those of most other fruit trees, and unless great care is exercised when the tree is taken up it is almost impossible to get more than a small percentage of the root system, thus reducing the chance of making the tree live when transplanted.

From time to time valuable trees have been discovered, cared for and even in some cases transplanted or propagated. Most of these have been soon neglected or destroyed, until there are comparatively few varieties of marked value available for general distribution.

Both De Soto and Jan de Laet when describing the ripe fruit of the native persimmon call it a "delicious little plum," and John Smith and other writers of the seventeenth century speak of it as a plum with the flavor of an apricot. This use of the word "plum" doubtless directed the attention of many people to the native species of *Prunus*, which include our wild cherries and plums.

BOTANICAL CLASSIFICATION.

The persimmon belongs to the ebony family (*Ebenaceæ*) and is known to botanists as *Diospyros virginiana*. It is the only member of the family which is indigenous to any extensive portion of the country.

NATURAL DISTRIBUTION OF THE PERSIMMON.

Roughly speaking, the persimmon is indigenous to the southeastern quarter of the United States, being found in large numbers

in the fields and forests of that section. The more favored localities in Iowa and eastern Nebraska produce many fruits, but very few trees are found west of central Kansas. Scattering specimens in Connecticut and on Long Island mark the present northeastern limit of the species. A few trees in Rhode Island, New York, and Michigan which produce fairly well indicate that the northern limit of cultivation may be extended whenever economic conditions (that is, the value of the fruit for food or the tree for ornamental purposes) seem to warrant.

The zone of greatest productivity and adaptability, wherein appear by far the largest number of promising types, extends from Maryland, Virginia, and the Carolinas westward through Missouri and Arkansas. The persimmon thrives equally well on the sands of the Coastal Plain, the shales of the Allegheny Mountains, the muck of the river-bottom lands, and the chert of the Ozarks.

GENERAL DESCRIPTION OF THE PERSIMMON.

HABIT OF GROWTH.

Throughout the habitat of the persimmon there is a wide variation in the size and growth of the trees and in the form, size, color, and number of seeds of the fruit. The three characters seem to indicate two types, upright and drooping, and these tree types are closely allied with the fruit types.

When grown in the open, persimmon trees rarely reach a height of 50 feet. In a dense forest growth they sometimes reach 70 or 100 feet, but that is uncommon. The characteristic checking of the bark of an old tree, which is shown in figure 1, aids one to recognize the species. The top of the tree is usually roundish or conical in form. Large trees are often somewhat irregular, owing to the breaking of limbs by heavy crops of fruit; moreover, it is a characteristic of productive trees to prune themselves by dropping many of the fruit-bearing twigs. The branches are always spreading, often



FIG. 1.—An old persimmon tree which shows the characteristic checking of the bark.

coming out almost at right angles to the trunk and then drooping more or less, especially after the tree has borne a few crops.

The leaves are elliptical or slightly ovate in form, acuminate at the apex, measuring from 3 to 6 inches in length and 1 to 3 inches in width, with a short petiole. In color, they are a dark glossy green on the upper surface and a grayish green underneath. Trees differ markedly, however, in habits of growth, as is shown in figures 2, 3, and 4.

FLOWERING HABIT.

The flowers resemble little four-lipped urns of wax, from one-fourth to three-fourths of an inch in length, the color varying from a greenish

yellow to a milky white. They are borne on short stalks and appear from the last of April in the extreme South until the middle of June at the northern limit of the persimmon habitat.

The trees are generally dioecious; that is, the pollen-bearing and fruit-producing flowers are borne on separate trees. The pistillate or fruit-producing flowers are borne singly, while the staminate or pollen-bearing flowers are generally produced in threes. The pollen is very light and powdery, and



FIG. 2.—A persimmon tree of the upright type which produces large, oblate fruits and is here used as a dooryard tree.

while it is generally distributed by the bees that frequent the tree in great numbers during blossoming time it can also be carried great distances by the wind.

FRUIT CHARACTERS.

The fruit is a true berry, containing sometimes as many as eight seeds in its pale, translucent flesh. It varies in form from oblate to oblong and in diameter from three-fourths of an inch to 2 inches

There is a wide range in color, varying from yellow to pale orange and even to a dark red, with many varietal markings, often blushed and covered with a bluish bloom. When green, persimmons are generally very astringent and puckery, because of the large quantity of tannin contained in the flesh, but when thoroughly mature and ripe the flavor is rich and sweet, and the consistency varies between that of a baked apple and a soft custard. The fruits of many late varieties turn a rich dark red and partially dry on the trees, somewhat resembling dates in appearance and flavor.

POSSIBILITIES OF IMPROVEMENT.

The season of the native persimmon is probably longer than that of any other wild fruit, both locally and over the country as a whole. In many sections the earliest and the latest varieties may be found growing side by side, or at least within a few miles of each other. The Bureau of Plant Industry has records for both early and late varieties from the

southern part of Georgia and Florida. In the District of Columbia there are some trees which ripen their fruit in August and others on which it hangs until February.

Generally speaking, the best fruits are neither the earliest nor the latest, but rather those that ripen just before the beginning of the tree's dormant season. The latest varieties are still immature when the leaves fall or when they are killed by frost, and they must complete the ripening process within themselves instead of drawing nourishment from the tree until they have grown to maturity.

The largest as well as the best fruits are those that ripen about the time the trees shed their leaves. The early varieties are nearly all medium in size, and the late varieties which hang on until cold weather



FIG. 3.—A persimmon tree of upright habit of growth which produces fruit of the pyriform type, ripening in midseason.

are generally small. Seedless fruits, as a rule, are smaller and earlier than those with seeds produced on the same trees.

The wide variations shown by the fruit in size, color, season of maturity, and tendency to seedlessness, and by the trees in size, shape, and vegetative vigor indicate the possibility of greatly improving the native persimmon. Up to the present time one essential factor has been overlooked in all attempts at breeding better varieties. That factor is the parentage of the male or pollen-bearing tree. Without a knowledge of the characters represented in the male parent there is no certainty as to the results of the crossing and the possibility of the line breeding which is essential to the rapid development of improved varieties. Definite efforts should be made



FIG. 4.—A persimmon tree which has a drooping habit of growth and produces fruit of the oblong type.

tree. Twenty or thirty nurserymen are selling seedling trees for ornamental planting and half a dozen others have selected named varieties of special merit which they offer for the production of fruit.

In some of the large cities and towns within the persimmon habit the wild fruit can be purchased during the autumn and early winter from the dealers who occupy the open stalls in the public market. A few enterprising growers adjacent to large cities have built up a demand which they find themselves unable to supply.

breeding work to secure pollen-bearing trees of known parentage. They should be selected from among trees grown from seed produced on the most desirable fruit-bearing trees.

PRESENT STATUS THE NATIVE PERSIMMON.

Throughout the region where persimmons are found in abundance the fruit is considered as being "good for dogs, hogs, and 'possums." Occasionally a family is mentioned as having lived for several months upon the fruit from a single large

The methods of utilizing the persimmon are at present rather limited. Fresh fruit is used in various ways—in making a few forms of bread or pone, in preparing certain homemade beverages and catmeats, and as forage for the hogs and dogs which get most of their living from the woods.

The object of this publication is to set forth the best methods of propagating and cultivating persimmon trees, to call attention to the many trees worthy of propagation, to indicate the food value of the fruit, and to enumerate various ways in which persimmons may be prepared.

PROPAGATION OF THE PERSIMMON.

As is the case with most tree fruits, the persimmon does not reproduce its varietal characteristics through the seed, and other methods of propagation are, therefore, necessary to perpetuate desirable varieties. Propagation of the persimmon by the methods commonly employed with tree fruits is more difficult than for such fruits as the apple or the peach. The methods described below have been found successful in actual practice.

SEEDAGE.

The seeds of the persimmon are scattered by mammals and birds and in the natural sequence of events reach the ground in the fall or winter without becoming dry. They are lightly covered with grass leaves and are subjected to the varying temperatures of winter, always remaining moist. The following spring the seeds sprout as soon as the soil becomes warm enough, provided that the conditions accompanying the rise in temperature do not dry them unduly. Seeds which fall under the trees are usually too much exposed to the atmosphere and dry too much to admit of germination.

Seeds that are gathered for propagating purposes should be stratified at once. If they are allowed to dry out it is often necessary to soak them for two or three days before they are planted, the water being renewed each day at a boiling temperature.

The seed bed in which persimmon seedlings are grown should be located on well-drained land where the soil is rather light and well supplied with humus. The ground should be plowed deep with a moldboard plow unless the subsoil is friable enough to permit the ready penetration of the long taproots which characterize the growth of persimmon seedlings.

The seed may be planted either in the fall or spring, after being stratified as described above. It is commonly planted in shallow drills and lightly covered with soil to a depth of one-half inch or a little more.

CUTTAGE.

ROOT CUTTINGS.

The roots of persimmon trees sprout readily when the top is removed or when the main stem meets with serious injury. This is illustrated in figure 5, which shows the development of sprouts from the roots of a seedling tree two months after the removal of the top.



FIG. 5.—A 2-year-old seedling persimmon tree which has been grafted. It has been in a propagating bed in a greenhouse under artificial heat for two months. The sprouts on the roots show how easily the roots may be used as a means of propagating the variety.

During this period the seedling had been in a propagating bed in a greenhouse, under artificial heat. This illustration also offers an explanation for the occurrence of the large clumps of similar trees that are to be found in many abandoned fields. At some time the original tree was cut off near the surface of the ground and the roots sent up sprouts which, being undisturbed, developed into trees bearing similar fruit.

Roots the size of a lead pencil or larger can be used in propagating the persimmon. They should be cut into pieces 6 or 8 inches long, the ends sealed with grafting wax, hot beeswax, or pitch, in order to prevent the decay of the

wood. They develop rapidly in the soft, spongy wood, and the cuttings should then be buried over winter in sand or in a nursery row. They will grow readily the following spring, provided the moisture supply is plentiful until they become well established.

WOOD CUTTINGS.

Cuttings of the branches may be treated in much the same way as root cuttings. Small twigs are unsuitable for purposes of propagation.

n (1) because they lack sufficient substance to produce the hus and root formation and (2) because it is extremely difficult prevent the organisms of decay from entering the soft, porous, year-old wood. The cuttings should be waxed or pitched at both ends and buried until well callused and the roots have started. They may then be planted in a nursery row and vegetative growth encouraged.

Wood 2 or 3 years old may be selected for cuttings, but care must be exercised to procure good, strong buds. The cuttings may be taken at any time after the trees become dormant in the fall and may be placed in cold storage or in sand until wanted. It is most important, however, that the ends of the cuttings should be dipped immediately into melted wax in order to exclude the air. If they have been exposed for even a few hours they should be retrimmed and waxed before being put in cold storage or sand.

GRAFTAGE.

Those who have trees bearing exceptionally fine persimmons will find the different methods of grafting admirably adapted to top-working the worthless trees about the place with the better varieties, thus changing them to useful fruitfulness.

Top-worked, or grafted, portions of old trees will bear two or three years earlier than trees which come from buds or grafts on 1 or 2 year old stocks. These seedling stocks, budded or grafted with selected variety, will bear one or two years earlier than those produced from cuttings.

The scions to be used in chip budding, cleft grafting, and whip grafting should be cut during late winter. All scions should be kept cool and moist until used. The budding and grafting should be done as soon as the trees which are to be grafted start to grow.

Because of the similarity in the operations of budding and grafting they are here treated together under the general heading of graftage. The various methods which have been found to be best adapted to the persimmon are here discussed.

SELECTION OF SCIONS AND BUD STICKS.

When selecting scions or bud sticks care must be exercised, just as when propagating by wood cuttings, to procure wood with strong, well-developed buds. On twigs of the last season's growth the best buds are generally near the base, where they are supported on more mature wood than those near the tip. In wood more than a year old, most of the buds near the tip have already produced branches, thus making this portion of the twig unsuitable for use in budding or grafting.

The method employed in budding persimmons largely determines the character of the wood that should be selected as a source of buds.

For the common shield or T bud, the basal half of the new growth is preferable because the bark is thinner than that on older wood and the buds fit closer and better than where wood with older and thicker bark is used. Moreover, the buds near the base of the new wood are better than those toward the tip, because the latter are more irregular in outline that it is difficult to fit them closely to the stock.

When the chip-bud method is used it is essential that the bud stick have sufficient body to allow the removal of the bud with a clean, solid chip adhering thereto. A bud stick should never be larger than the stock on which the buds are to be worked. If it is too large in relation to the size of the stock which is to receive the bud, the chip will be so broad and flat that it can not be properly

fitted into any notch which it is possible to make in the stock.

For annular or patch budding the most satisfactory buds are those taken from wood that is 2, 3, or even 4 years old. Such buds are but lightly attached to the wood and have a good body of bark, which makes them easy to handle and not liable to drop out. Buds taken from near the base of large, vigorous, new shoots will also give good results.

The various methods of budding and grafting that have proved satisfactory in propagating the persimmon have been described in detail in publications

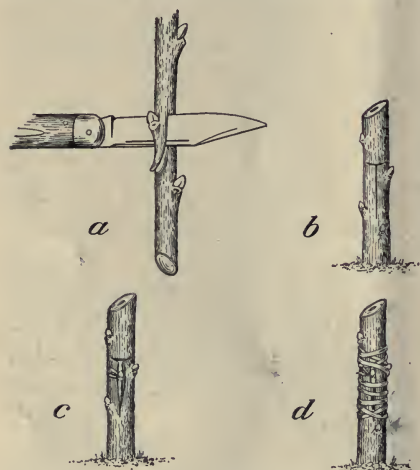


FIG. 6.—The different steps in shield or T budding: *a*, Cutting the bud; *b*, preparing the stock; *c*, inserting the bud; *d*, tying.

of the Department of Agriculture relating to other fruits and to nut trees. For convenience in the present connection, extracts from these publications are inserted below.

SHIELD OR "T" BUDDING.¹

The height at which buds are inserted [where small seedling stocks are used] varies with the operator. In general, the nearer the ground the better. The cut for the reception of the bud is made in the shape of a letter T. (Fig. 6, *b*.) Usually the crosscut is not quite at right angles with the body of the tree, and the stem to the bud starts at the crosscut and extends toward the root for an inch or more. The flaps of bark caused by the intersection of the two cuts are slightly loosened with the ivory heel of the budding knife, and the bud, grasped by the leaf stem as a handle, is placed under the flaps and firmly pushed in place until its cut surface is entirely in contact with the peeled body of the stock. (Fig. 6, *c*.) A ligature is then tightly drawn about, above, and below the bud, to hold it in place until a union shall be formed.

¹ Corbett, L. C. The propagation of plants. Farmers' Bulletin 157, pp. 22-23.

. 6, d.) Bands of raffia about 8 or 10 inches long make a most convenient tying material. As soon as the buds have united with the stock the ligature should be cut, in order to prevent girdling the stock. This done, the operation is complete until the following spring, when all the trees in which the buds have "taken" should have the cut off just above the bud.

Shield budding may be done at any time when the trees are in vigorous growth and when well-matured buds of the current season's growth can be obtained. This period usually extends from July to September. When budding seedlings it may sometimes be necessary to delay the operation until the latter part of the season, in order that the stock may develop to a satisfactory size; but when top-working larger trees by this method well-developed buds may be handled whenever the trees are in a vigorous condition of growth. Figure 7 shows a branch of a young persimmon tree on which a shield T bud has made considerable growth.

Some of the precautions which have been found important to observe when propagating pecans are equally applicable in the propagation of persimmons. The following directions for budding pecans according to the various methods are therefore presented here.¹

ANNULAR BUDDING.

The process [of annular budding] is also known as "ring" and "flute" budding.

It is performed during the midsummer months at such time as the bark is found to slip (usually in the evening) most readily. In some seasons this period may be very brief, lasting only a few days, while in other years the time during which annular budding may be successfully performed extends over a period of several months. In the latitude of southern Georgia it is not uncommon for this method to be successful from as early as May 10 until late in July or even in August.

Annular budding consists merely in transferring a ring of bark to which is attached a bud of the desired variety from a bud stick² to the trunk or branch of another tree in place of a similar ring of bark previously removed. Specially designed tools have been devised for the purpose of cutting the rings. Two ordinary propagating knives with single blades may be fastened together and made to answer the purpose, although they are less liable to make uniform incisions. Cut a ring of bark from the bud stick with one of the tools, slit it with a single-bladed knife, and lift from its bed or matrix," as it is technically called. Discard this bark and from the bud stick



FIG. 7.—A shield or T bud after considerable growth has been made.

¹ Reed, C. A. The pecan. Bureau of Plant Industry Bulletin 251, pp. 25-31.

² The bud stick is a branch cut from a tree of the variety to be propagated.

remove a similar ring, in the center of which is a dormant bud. The bark of the bud stick should be slit on the side opposite the bud. Immediately place this ring in the space left by removing the bark from the stock and wrap at once with waxed cloth, taking care not to cover the bud (fig. 8).

PATCH BUDDING.

When the annular method is used it is obvious that the stock and scion must be nearly the same size. If the bud stick is slightly larger than the stock a portion of the



FIG. 8.—Annular budding. *a*, Bud stick from which the bud has been removed; *b*, the bud ready for insertion in the matrix of the stock; *c*, the stock ready to receive the bud; *d*, the bud after being placed in position and carefully wrapped; *e*, growth taking place, the wrapping having been removed; *f*, growth from the bud supported by being tied to the stock (*g*) above the union. Note the scars above the union, where the buds were removed in order to direct the flow of sap to the new bud.

The pattern is then removed, the section of bark outlined in the stock is lifted and the bark from the bud stick is put in its place. Some varieties of the pecan are more difficult to bud successfully than others; with such varieties the annular method or a near approach to it, is generally most successful.

With the average sorts, however, the tendency among the more experienced nurserymen is much inclined to favor the patch method.

bark to which the bud attached may be cut away so that the two ends of the ring just meet around the stock. If the bud stick should be smaller than the stock, a strip of bark on the latter may be left in position to complete the ring. In actual practice, rings which extend only partly around the stock are more commonly used. Such process, however, is not true annular budding, because any bark which extends only partly around the stock is merely a patch. It is to this deviation from the annular method of budding that the term "patch budding" has been applied. A tool specially designed for patch budding consists of four thin steel blades fastened together in the form of a rectangle, five-eighths of an inch wide by 1 inch long, and is used as a punch.

A cut is made in the bark of the bud stick about half an inch in width by three times as long, in the center of which is the bud. The piece of bark so outlined is removed from the bud stick and laid over that of the stock. Using this as a pattern, incisions are then made around the bark of the stock

The buds best suited to annular or patch budding are those in the axils of the leaves at the base of the current season's growth. It is well worth the time required to clip the leaves away, close to the buds, 10 days or 2 weeks before the bud is wanted, for by so doing the wound will heal over before the bud is needed; otherwise a serious lessening of the vigor of the bud through evaporation may take place.

CARE OF ANNULAR AND PATCH BUDS.

In annular budding the added ring of bark sometimes unites with the stock promptly, permitting the upward flow of sap to proceed without much interference. When this is the case the top should be carefully pruned back to such a degree as is necessary to direct sufficient sap into the new bud to cause it to swell. This pruning should not be done with too great severity, as an oversupply of sap is liable to accumulate under the bark of the new bud and cause it to decay, or, as it is termed, "to drown" the bud.

If the tree is young and the growth has been rapid, precaution should be exercised in cutting back the top, in order not to expose the tender bark to the heat of the sun. A sufficient amount of foliage should be left as a protection from the hot sun. If the supply of sap be limited, it will be well to cut off all buds in the top of the stock, as shown in figure 9. All dormant buds, both above and below the new bud, should be rubbed off as soon as they begin to swell. The wrapping about a new bud must be cut away as growth begins. As the union of a bud with a stock made by any method of budding is at first merely the uniting together of bark and not of wood, it is necessarily weak during the first few months. To avoid danger of breaking out at the union, the new tops should be provided with extra support. For this purpose side stakes driven into the ground are sometimes used, but these are expensive and unnecessary. By leaving a stub of the original top 8 or 10 inches

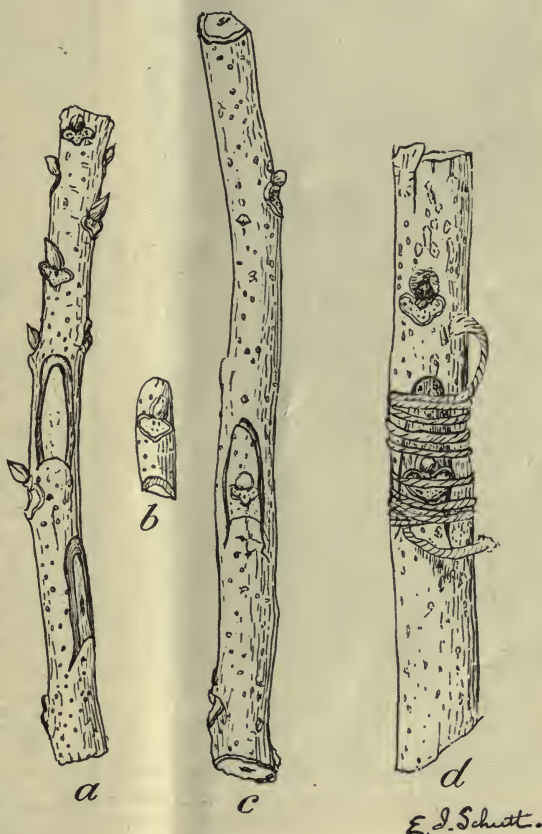


FIG. 9.—Chip or "dormant" budding. *a*, The bud stick; *b*, the bud ready for insertion; *c*, the bud inserted in the matrix of the stock; *d*, the bud securely tied in place.

long, entirely denuded of foliage (fig. 8), the new top may be quickly tied to it, and when no longer needed the dead stub may be cut away close to the union.

CHIP BUDDING.

Propagation by chip budding is performed in the early spring or late in the dormant period. Because of being done at this season it is also known as "dormant" budding.

With a sharp knife a downward cut is made below the bud on the bud stick to a depth of perhaps one-eighth of an inch. Raising the knife to a point above the bud, a long downward cut is made, which meets the lower end of the first cut, and the bud is removed with a chip attached, as shown in figure 9. A similar chip is removed from the stock, and the desired bud is put in its place. This should be carefully wrapped with such material as will hold the cambium layers of the stock and the bud firmly together on at least one side.

Subsequent treatment similar to that already described for annular and patch budding should be given young trees propagated in this summer.

Trees of the pecan species are difficult to propagate asexually; that is, neither buds nor scions "take" with the readiness of ordinary fruit trees. The inexperienced



FIG. 10.—A chip bud on a branch after the bud inserted had made considerable growth.

operator, therefore, must expect a very low percentage of living buds as the result of his first attempts. Skilled propagators, however, are now so successful that under favorable conditions the percentage of failures is no longer a matter of consequence.

No attempt to bud pecans should be made on rainy days, or in early mornings following heavy dews. Some nurserymen even go so far as to select their men for budding the pecan, assigning those who perspire most freely to other duties. Extremely hot days should be avoided, especially if accompanied by drying winds. Moderately cool, cloudy days without wind or rain are the best for pecan budding.

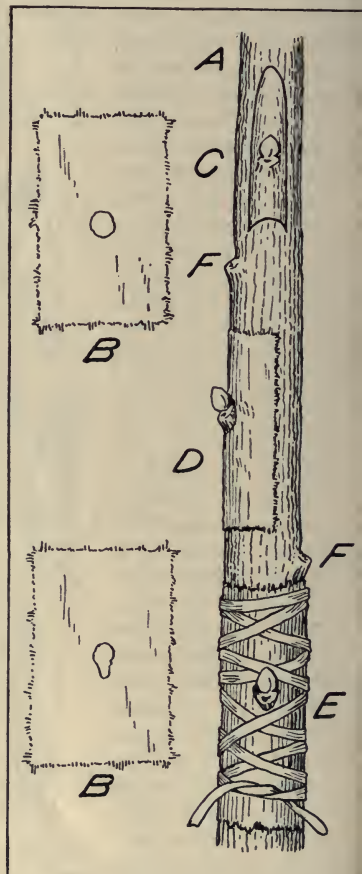


FIG. 11.—Method of using a bud protector on a chip bud. The protector may be used in similar manner in all of the different forms of budding. A, stock; B, waxed cloth protector; C, chip bud fitted into notch in stock; D, protector in position over the bud; E, protector and bud wrapped and tied; F, scars of buds removed from stock. (Adapted from drawing in American Fruit and Nut Journal, vol. 6, whole no. 94, p. 23.)

Figure 10 shows a persimmon chip bud which has made considerable growth.

PROTECTION OF BUDS.

A very satisfactory means of affording protection to buds inserted by any of the foregoing methods is shown in figure 11. These waxed fields are intended as a substitute for the waxed strips previously mentioned, and their preparation and use has been described as follows:¹

In making the waxed wrappers, old domestic flannel from worn bed sheets or undergarments may be used. Tear it into strips 2 feet long and 6 inches wide; then fold it into squares and dip it into a tin plate of hot, melted beeswax. The wax will strike through instantly, and then the strips may be held up by one end and the surplus wax allowed to drip back into the tin plate. When cool, the cloth may be torn into * * * squares of proper size. No pressing or squeezing is necessary. The beeswax answers the purpose in every way; it saves the buds, and that is the end in view. These

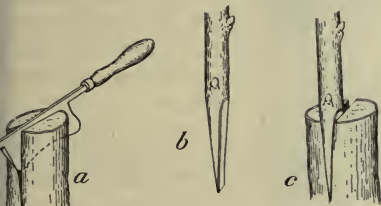


FIG. 12.—Cleft graft: *a*, Stock being split by special grafting tool; *b*, scion ready for insertion; *c*, scion in place ready for waxing.

waxed wrappers may be left on the buds the whole season. When the bud shoots are an inch or so in length, the strings may be unwound from so much of the wrappers as cover the buds; but tie the upper end of the wrapper, which is above the bud, firmly to the projecting stub. The eyelets² in the wrappers will open as the bud shoots grow, and protection will be afforded against hot suns and chilly nights.

CLEFT GRAFTING.³

This style of graft is particularly adapted to large trees when for any reason it becomes necessary to change the variety. Branches too large to be worked by other methods can be cleft-grafted.

A branch 1 or 1½ inches in diameter is severed with a saw. Care should be taken that the bark be not loosened from any portion of the stub. Split the exposed end with a broad, thin chisel or grafting tool (fig. 12, *a*). Then with a wedge or the wedge-shaped prong at the end of the grafting tool spread the cleft so that the scions (fig. 12, *b*) may be inserted (fig. 12, *c*).



FIG. 13.—A cleft graft made on a small branch.

¹ American Fruit and Nut Journal, v. 6, no. 94, p. 22.

² The eyelet referred to is the small hole in the center of the protector shown in figure 11.

³ Corbett, L. C. The propagation of plants. Farmer's Bulletin 157, pp. 17-18.

The scion should consist of a portion of the previous season's growth and should be long enough to have two or three buds. The lower end of the scion, which is to be inserted in the cleft, should be cut into the shape of a wedge, having the outer edge thicker than the other. In general, it is a good plan to cut the scion so that the lowest bud will come just at the top of this wedge, so that it will be near the top of the stock. The importance of having an intimate connection between the growing tissues of both scion and stock can not be too strongly emphasized, for upon this alone the success



Fig. 14.—A cleft graft made at the crown, the soil which normally covered the union having been removed in order to show the parts to better advantage.

15, *b*), and when the two parts are forced together, as shown in figure 15, *c*, the cut surfaces will fit neatly together, and one will nearly cover the other if the scion and stock are of

grafting depends. To make this contact of the growing portions doubly certain, the scion is often set at a slight angle with the stock into which it is inserted, in order to cause the growing portions of the two to cross.

After the scions have been set the operation of cleft grafting is completed by covering all cut surfaces with a layer of grafting wax.

Cleft grafting has given satisfactory results with the persimmon, both on the branches (fig. 13) and at the crown (fig. 14).

WHIP GRAFTING.¹

Whip grafting is the style almost universally used in root grafting. It has the advantage of being well adapted to small plants.

The graft is made by cutting the stock off diagonally—one long smooth cut with a sharp knife, as shown in figure 15, *a*. Place the knife about one-third of the distance from the end of the cut surface, at right angles to the cut, and split the stock in the direction of its long axis. Cut the lower end of the scion in like manner (fig.

¹ Corbett, L. C. The propagation of plants. Farmers' Bulletin 157, pp. 18-19.

the same size. A difference in diameter of the two parts to be united may be disregarded unless it be too great. After the scion and stock have been locked together, as shown in figure 15, *c*, they should be wrapped with five or six turns of waxed cotton to hold the parts firmly together.

While top grafting may be done in this way (fig. 16), it is in root grafting that the whip graft finds its distinctive field. When the roots are cut into lengths of 2 to 5 or 6 inches to be used as stocks, the operation is known as piece-root grafting. Sometimes the entire root is used.

In ordinary propagation by means of whip grafts, the scion is cut with about three buds, and the stock is nearly as long as the scion. The graft is so planted as to bring the union of stock and scion not very far below the surface of the ground.

CARE OF WHIP GRAFTS.¹

When grafted by the whip-graft method the young trees will require little subsequent attention other than pruning and ordinary cultivation. When the root is that of a very young tree there will be no danger of the supply of plant food being such as to induce a growth of top that is too rapid, as is frequently the case with cleft grafts, especially in the tops of old trees. While temporary staking as a support to the union is not necessary, in numerous cases stakes will be highly essential to insure erect growth. The moisture of the ground causes the wrapping material to decay in the course of a few weeks, and it is therefore not necessary to cut the bands.

The operation of grafting most fruits is generally successful if performed in the spring when the trees are still dormant, or even after growth has started slightly, provided the scions are entirely dormant. In the case of the persimmon, however, much more satisfactory results appear to be obtained when the grafting is delayed until the trees have definitely started into new growth. The scions must be kept dormant.

In all of the various methods of budding and grafting the persimmon it is of the utmost importance that the cut surfaces of both bark and wood be protected with as little delay as possible from chemical change due to exposure to the air. Protection is afforded by covering the wounds with grafting wax, waxed cloth, or similar devices.

STOCKS AND NURSERY TREES.

The stocks in the nursery row should stand at least 6 inches apart, to afford space for root development and to give the workmen plenty of room when the trees are budded or grafted. The young trees



FIG. 15.—Whip graft: *a*, Stock prepared; *b*, scion prepared; *c*, stock and scion fitted together ready for tying.

¹ Reed, C. A. The pecan. Bureau of Plant Industry Bulletin 251, p. 25.

in the nursery should receive fair cultivation, and the roots should be pruned each year with a tree digger or spade in order to keep the root system small enough to be handled with ease when the trees are dug. The 2-year-old roots are always preferable for stocks. Older roots which are small enough to be easily handled are likely to be



FIG. 16.—A whip graft after attaining considerable growth.

stunted, and 1-year-old roots must be very thrifty to produce the desired growth in the graft.

Trees which have been produced under conditions favorable for development may be planted in their permanent location after they have made one season's growth in the nursery. Some varieties, however, are much more vigorous than others. It may be advisable to grow the weaker sorts in the nursery for two years



FIG. 17.—Persimmon trees after making one season's growth in the nursery. These trees were propagated by grafting on seedling stocks. The bundle on the left is the Golden Gem variety; on the right, the Miller. The largest trees are 4 to 5 feet tall. The difference in the size of the trees in the two bundles is due to the difference in the natural vigor of growth of these two sorts.

before transplanting them. Figure 17 shows two varieties of grafted persimmon trees that have made one season's growth in the nursery. On account of the very long taproot which persimmon trees habitually develop, particularly when propagated on seedling stocks, much care must be exercised to avoid undue injury to the root systems when the trees are dug from the nursery. Moreover, because of the deep-rooting habits of these trees a deep soil should be selected for their permanent location.

CULTIVATION OF THE PERSIMMON.

PLANTING.

The transplanting of the young trees may be done at any time during the dormant period, from late autumn to early spring, when the roots can be protected from freezing temperatures and evaporation and when the soil is in a suitable condition for handling. If the trees have been properly taken up without undue injury to the roots, the tops will need little or no pruning. If, on the other hand, the root systems have been severely reduced, the tops should be headed back until the total length of branches and trunks corresponds in a general way to the total length of the main roots. Wounds in both tops and roots should be waxed as soon as made.

Young persimmon trees have large, deep root systems and should be planted 2 or 3 inches deeper in the orchard than they were in the nursery row. In setting them out the soil should be packed thoroughly around the roots. A round-pointed wooden tamp is a very serviceable tool with which to make the earth compact as the hole is filled up. The planting plan varies with the type of tree desired. If it seems desirable to grow low-headed trees with the expectation of producing large fruit that can be readily picked by hand, the permanent trees should be placed at least 16 or, better still, 20 feet apart each way. If, however, a large bulk of fruit is desired as stock feed to be scraped from the ground or picked up by animals, a fair degree of success may be expected if the trees are planted 10 feet apart each way.

TILLAGE.

Probably the persimmon can be more successfully intercropped than any other fruit tree, owing to the depth of its root system. Blackberries, dewberries, strawberries, and vegetables thrive very well among persimmons until the shade becomes too dense. When the trees shade the ground, it is best to seed down the orchard if it is to be used as a run for chickens, calves, pigs, or other animals and the fruit used as stock feed. If it is planned to produce fruit for market purposes, however, the same cultivation should be given the ground as in a commercial orchard of peach or other fruit trees.

PRUNING.

The pruning of the persimmon varies with the variety. There is a tendency for the tree to prune itself, as many of the fruit-bearing twigs die and drop off with their fruit, thus making the natural open growth of the trees still more open and reducing to a minimum the necessity for pruning. There are two points, however, which should be borne in mind: (1) The upright tendency of some of the most vigorous varieties should be checked by pinching off the tender growing tips as they get out of reach, and (2) those trees that do not prune themselves sufficiently to keep the top well open should be thinned by removing entire limbs either main or secondary. This practice is preferable to opening the tops by thinning out the small branches and thus leaving the larger limbs bare for a considerable portion of their length. Thinning admits light and air, and at the same time a stronger vegetative growth is induced; the result is that the size of the fruit is kept uniform and the crops are made more regular by reducing the tendency to overbear on alternate years.

All wounds should be painted or otherwise covered as soon as made, in order to prevent the wood from drying or dying back and decay from entering the body of the trees.

DISEASES AND INSECT PESTS.

The persimmon is exceptionally free from the attacks of diseases and insect pests. Probably the most important of the insect enemies of the persimmon is the hickory twig girdler. The following brief account of the life history and habits of this insect, prepared for this bulletin by the Bureau of Entomology, may be of interest to those who anticipate growing the persimmon:

The hickory twig girdler, *Oncideres cingulata* Say, makes its appearance about the middle of August and may be found until the first of October. It begins depositing its eggs about the latter part of August and continues the process well into October. The eggs hatch in from seven to nine days after deposition, and the young larva begins to feed on the inner bark and wood at the point where the egg was inserted beneath the bark. As the larva increases in size it continues to feed on the wood, going deeper into the twig, and by the time its full growth has been attained it often completely hollows out the twig for some little distance from the point where it began work. Some of the larvæ attain their full growth and begin transformation to pupæ about the first of August. Others do not make this change until near the middle of September. The pupal stage lasts from 10 to 14 days, when the insects transform to adults and emerge from the twigs where they have spent their lives. Several days pass before they begin laying their eggs in the small limbs and twigs.

The injury caused by this insect occurs in the process of oviposition. The adult gnaws a small hole in the bark, usually just above or just below a bud, and the egg is inserted beneath the bark by means of the ovipositor. Several eggs are usually deposited in a twig in this manner, and the insect then begins girdling the twig beneath the point of oviposition by gnawing out small pieces of the bark. A ring is thus made around the twig, perhaps a third of the way through, weakening it to such an extent that it is broken off by the wind during the winter or the following spring. The trees are often severely injured by having the young growth pruned off in this manner.

In order to control this insect the twigs should be picked up from the ground in June or early July. All twigs which are found at this time have been girdled and broken from the tree and should be collected and burned in order to destroy the insects which are inside them.

USES OF THE PERSIMMON TREE.

The largest purchases of persimmon wood are made by the manufacturers of cotton-mill supplies, who use the timber in making bobbins. The wood is well suited for this work, as it is strong, comparatively light, hard, elastic, and close grained, taking a high polish. Shoe lasts are also made to some extent from persimmon wood.

The tree has some value for shade and ornamental purposes. Concerning this use of the native persimmon Mr. F. L. Mulford, landscape gardener of the Department of Agriculture, writes as follows:

As an ornamental for lawns the persimmon compares favorably with any of the shade trees used on private grounds, provided that it does not overhang a sidewalk, where the dropping of fruits would be objectionable. The broad, glossy leaves on the gracefully drooping branches give a dense shade from early in the spring until the autumn is well advanced.

In the early summer the little waxlike flowers fill the air with a delicious fragrance, somewhat resembling that of the calla lily. When the fruit begins to mature, yellowish and golden clusters appear among the dark-green leaves and add to the beauty of the tree until they fall. Some of the later varieties are ornamental after the leaves have fallen and even until well into the winter.

USES OF THE PERSIMMON FRUIT.

The only fruit which equals the persimmon in food value is the date. This is shown by the analyses presented in Table I.

TABLE I.—*Comparative analyses of fresh fruits, showing their food values in percentages of the weight of the fruit.*¹

Fruit.	Total solids.	Ash.	Protein.	Sugars.	Crude fiber.
	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
Apples.....	13.65	0.28	0.69	10.26	0.96
Blackberries.....	13.59	.48	.51	4.44	5.21
Cherries.....	22.30	.65	.81	11.72	.62
Currants.....	15.23	.72	.51	6.38	4.57
Dates.....	^{2,3} 66.86	⁴ 1.20	⁵ 1.48	⁶ 56.59	⁷ 3.80
Figs.....	20.13	.57	1.34	15.51	-----
Grapes ⁸	² 21.83	.53	.59	⁹ 17.11	3.60
Oranges (Navel).....	13.87	.43	.48	15.91	-----
Peaches ⁷	² 10.60	.40	.70	⁶ 5.90	3.60
Pears.....	16.97	.31	.36	8.26	4.30
Persimmons ¹⁰	² 35.17	.78	.88	⁹ 31.74	1.43
Plums.....	15.14	.61	.40	3.56	4.34
Raspberries.....	13.79	.49	.53	3.95	5.90
Strawberries.....	9.48	.60	.97	5.36	1.51

¹ Data, with exceptions as noted, from Bureau of Chemistry Bulletin 66, pp. 41-42.

² Dry matter.

³ Average of 11 analyses. See "Chemistry and ripening of the date," Arizona Agricultural Experiment Station Bulletin 66, p. 408.

⁴ See "Principles of nutrition and nutritive value of food," Farmers' Bulletin 142, p. 18.

⁵ Adapted from the two publications mentioned in footnotes 3 and 4.

⁶ Fats and carbohydrates.

⁷ See "Use of fruit as food," Farmers' Bulletin 293, p. 14.

⁸ See "The American persimmon," Indiana Experiment Station Bulletin 60 (1896), p. 52.

⁹ Nitrogen-free extract.

¹⁰ Average of 6 analyses in "The American persimmon," Indiana Experiment Station Bulletin 60 (1896).

Probably the most common use of the fruit is as feed for hogs. As a rule, the hogs are merely turned loose in lots where persimmon trees have come up naturally. Some, however, who appreciate the value of this fruit as stock feed have set out orchards in order to provide a definite supply for this purpose. If varieties are selected which ripen in a continuous sequence, the fruit will, in some sections, furnish forage for hogs from the last of August until early winter. A small area devoted to persimmons can thus be made a valuable asset for any general farm located in a persimmon district which includes hogs among its stock.

The persimmon fruits intended for shipment should, to avoid bruising, be carefully hand picked while still quite firm, that is, just as the flesh begins to soften. Fruits which can be delivered direct to the consumer should not be picked until fully mature and should also be handled with great care. Fruit of the later varieties, especially those of the oblong type, often hang on the trees for weeks, drying to about the consistency of the commercial date.

Quart and pint size berry boxes are commonly used when packing the fruit for market, the baskets being handled in the ordinary strawberry crates. Larger units would result in bruising the softer fruits and are therefore not advisable. Crates in which the individual fruits are placed in separate compartments are suggested for shipping the better grades of persimmons, and it is believed that a trade which will fully repay the expense and trouble of this method of handling can be built up in any town of moderate size. Persimmons which are placed in storage should be packed in egg crates or similar containers that hold the fruits separate.

RECIPES FOR USING PERSIMMONS.

Before the advent of the white man, the Indians mixed the pulp of this fruit with crushed corn and made it into a kind of bread. Now, there are many ways in which the fruit can be used, but the different methods are not well known, and many people with fine trees in their possession are allowing the fruit to waste because they do not realize its value. The dissemination of knowledge regarding the use of the persimmon in preparing very palatable food products should result in much wider use of the fruit. To this end a number of recipes are included in this publication.

Since heat makes the astringency of the persimmon more apparent, it is always well to add one-half teaspoonful of baking soda (bicarbonate of soda) to each cupful of persimmon pulp in all recipes where the fruit is subjected to heat. Although it has been proved by experiment that the soda may be omitted if the fruit is entirely free from astringency, it is better to use it until one is sure of the quality of the persimmon pulp.

PERSIMMON BREAD.

- | | |
|------------------------------------|------------------------------|
| 1 cup of persimmon pulp. | Yeast. |
| 1 cup of water. | Shortening. |
| $\frac{1}{2}$ teaspoonful of soda. | Flour to make a stiff dough. |

Set to rise, mold, and bake like other bread.

PERSIMMON CRUMPETS.

Take 1 pint of the sponge of persimmon bread which has been set over night, add one egg and enough milk to make a thin batter, set to rise for one hour, then bake on a hot griddle like griddlecakes. Serve hot with butter or sirup.

PERSIMMON GRIDDLECAKES.

- | | |
|--------------------------|------------------------------------|
| 1 cup of persimmon pulp. | 1 teaspoonful of baking powder. |
| 1 egg. | $\frac{1}{2}$ teaspoonful of soda. |
| 1 cup of flour. | Milk to make a thin batter. |

Bake and serve as above.

PERSIMMON-PEANUT GRIDDLECAKES.

- | | |
|-----------------------------------|------------------------------------|
| 1 cup of persimmon pulp. | 1 teaspoonful of baking powder. |
| 1 tablespoonful of peanut butter. | $\frac{1}{2}$ teaspoonful of soda. |
| 1 egg. | Milk to make a thin batter. |
| 1 cup of flour. | |

Bake and serve as above.

PERSIMMON-PEANUT MUFFINS (A GOOD RECIPE FOR CAMPERS).

- | | |
|--------------------------------------|------------------------------------|
| $\frac{1}{2}$ cup of persimmon pulp. | 1 teaspoonful of baking powder. |
| 1 tablespoonful of peanut butter. | $\frac{1}{2}$ teaspoonful of soda. |
| 1 cup of flour. | |

Press or cut in pats $\frac{1}{2}$ inch thick and bake in a quick oven.

COFFEE FRUIT CAKE.

Boil together 1 cup of molasses and $1\frac{1}{2}$ cups of minced dried persimmons for five minutes. Cream 1 cup of sugar, $\frac{1}{2}$ cup of butter and 1 egg, and add to the above. Stir in three-fourths of a cup of strong coffee and place on a warm stove. Add 2 cups of flour; $1\frac{1}{2}$ teaspoonfuls of mixed ground spice; $1\frac{1}{2}$ teaspoonfuls of a phosphate baking powder, or if preferred, 1 teaspoonful of baking powder and $\frac{1}{2}$ teaspoonful of soda. Bake in a moderate or slow oven 40 minutes to 1 hour.

PERSIMMON CAKE.

- | | |
|-----------------------------|------------------------------------|
| 1 cup of persimmon pulp. | 1 cup of flour. |
| $\frac{1}{2}$ cup of sugar. | 1 teaspoonful of baking powder. |
| 1 egg. | $\frac{1}{2}$ teaspoonful of soda. |
| Butter of size of a walnut. | |

Bake 40 minutes in a moderate oven. For a soft pudding leave out the eggs. For custard leave out the flour and the baking powder.

PERSIMMON PUDDING (CAKE OR PONE).¹

- | | |
|--------------------------------|-----------------------------------|
| 1 pint of fine persimmon pulp. | 3 cups of flour. |
| 1 cup of sugar. | 1 teaspoonful of ground cinnamon. |
| 1 quart of sweet milk. | 2 teaspoonfuls of baking powder. |

¹ The American persimmon. Indiana Experiment Station Bulletin 60, pp. 43-54, 1896.

PRESERVED PERSIMMON PULP.

Place equal amounts of persimmon pulp and sugar in glass or earthenware jars or in coated sanitary cans. (Never use cans of uncoated tin for persimmons.) Mix thoroughly and set in a cool, light place. Stir occasionally until the air is removed and seal with paraffin or waxed paper. The cans may be heated over a slow fire just enough to drive out the air, and should be sealed at once.

PRESERVED WHOLE PERSIMMONS.

Put a thin layer of sugar in the bottom of a jar; then a layer of whole ripe persimmons, then a layer of sugar; and so on until the jar is full. The sugar will soon dissolve and form a sirup. Press the upper fruits down under the sirup or add more sirup to the jars. Seal and store until used. The sirup may be drained off and the fruits served like dates, which they will resemble very much in both appearance and flavor.

PERSIMMON LEATHER.

Spread a thin layer of ripe persimmon pulp on waxed paper or on a large platter. Dry in the sun, in a fruit evaporator, or in the oven of a stove, leaving the oven door open. Remove the seeds. Add another layer of pulp, and repeat until the leather is of a thickness to handle easily. This may be diced or minced and used instead of raisins or citron in fruit cakes, cookies, or puddings.

PERSIMMON ICE CREAM.

2 cups of persimmon pulp. 1 cup of thick, sweet cream.

Beat together thoroughly and freeze like ordinary ice cream. The fruit must be thoroughly ripe and nonastringent.

PERSIMMON FRUIT ICE.

2 cups of persimmon pulp. 1 cup of sugar.

Beat to a creamy pulp and freeze.

PERSIMMON TAFFY.

Two cups of the sirup from the preserved whole persimmons. Add 1 cup of sugar and cook until it forms a hard ball in water. Pour on a buttered platter and pull. Cut in sticks and squares.

PERSIMMON FUDGE.

2 cups of persimmon pulp. 2 cups of sugar.

Cook over a slow fire, stirring occasionally, until graining begins. Add 1 teaspoonful of baking soda and stir over the fire until quite stiff. Spread on buttered platter or paraffin paper.

SELECTED AND CULTIVATED NAMED VARIETIES.

The native persimmon varieties that have thus far received names and been disseminated for cultivation have originated as chance seedlings, being brought into cultivation from the wild state. With few exceptions, the fruits of these varieties are of the oblate type. Brief descriptions of the fruit of some of the better known varieties follow.

DESCRIPTIONS OF VARIETIES.

Warrior. Origin, central Kentucky, where it ripens rather early; form, oblate; size, medium; color, yellow; practically seedless; flesh, soft; quality, very good.

Boone (*Daniel Boone*). Origin, Indiana, where it ripens during October and November; form, roundish oblate; size, medium; color, yellow, with a dull blush in the sun; skin, rather tough; seeds, numerous; flavor, sweet but not rich; quality, good.

Elmas. Origin, Scranton, Miss., where it ripens during October and early November; form, roundish oblate; size, medium to large; color, reddish yellow; skin, thin and tough; seeds, numerous; flavor, sweet and rich; quality, very good.

Early Bearing. Introduced from Cartersburg, Ind., where it ripens early in October; form, round ovate; size, medium; color, dull yellow; quality, good.

Early Golden. Origin, Illinois, where it ripens in September; form, oblong; size, medium to large; color, yellow; skin, thin; seeds, few; flavor, sweet; quality, very good.

Golden Gem. Introduced from Borden, Ind.; where it ripens from August to October; form, roundish oblong; size, medium to large; color, dark orange to red; seeds, few; flavor, rich and sweet; quality, good.

Locks. Origin, Washington County, Ind., where it ripens in October; form, roundish oblate; size, medium to large; color, dark red; skin, thin and tender; seeds, few; flavor, rich; quality, very good.

Josephine (*American Honey, Honey*). Origin near Bluffton, Mo., where it ripens in September; form, roundish oblate; size, medium; color, bright yellow, changing to pale translucent; skin, tough; seeds, few; flavor, sweet and rich; quality, good.

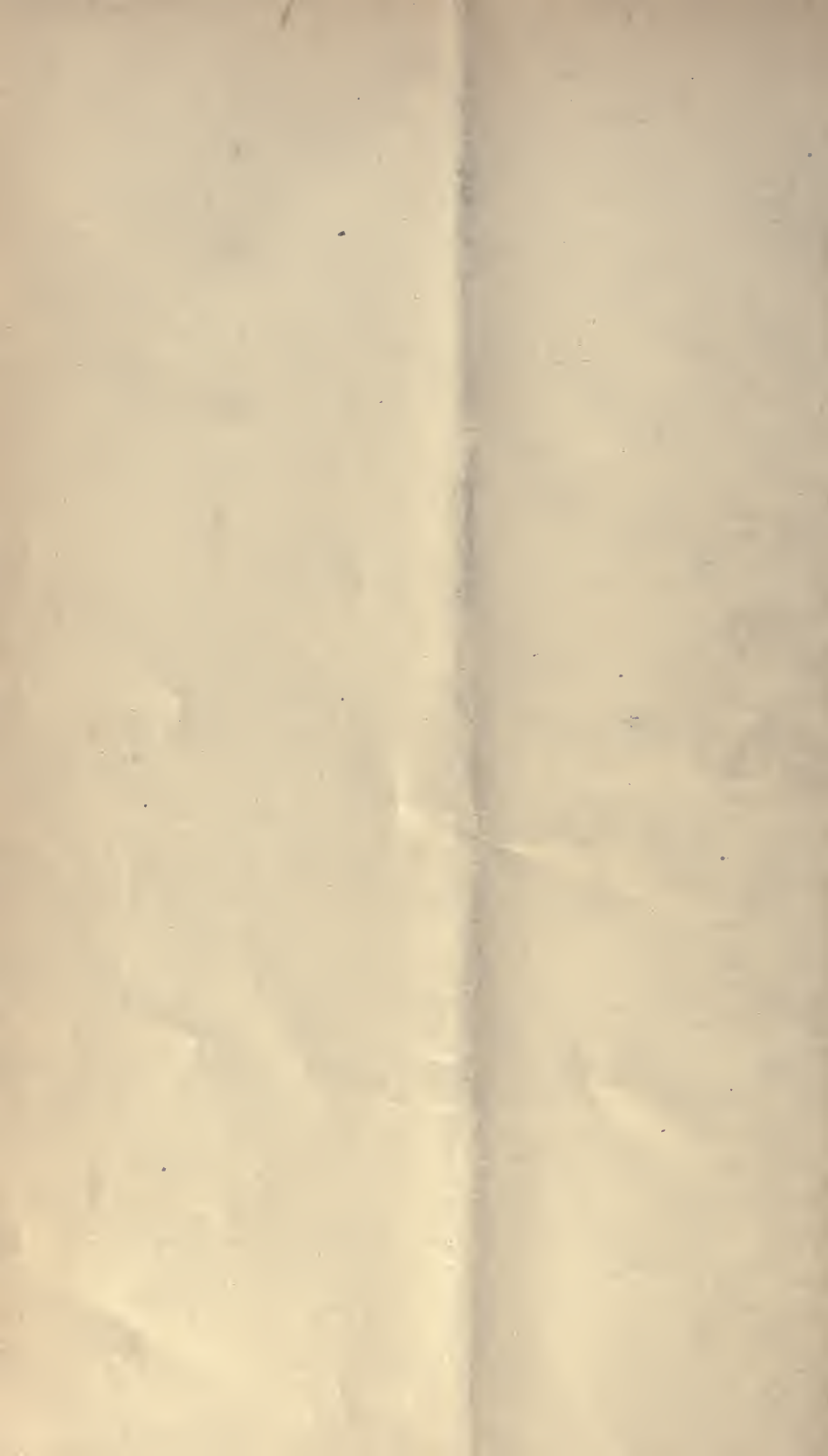
Kansas. Introduced from Missouri, where it ripens in September; form, roundish oblate; size, rather large; color, yellow splashed with red; flavor, rich; quality, very good.

Killer. Origin, Jackson County, Mo., where it ripens in September; form, roundish oblate; size, large; color, reddish yellow, translucent; skin, tough; seeds, rather numerous; flavor, sweet; quality, good.

Ruby (*Little's Ruby*). Introduced from Cartersburg, Ind., where it ripens during September and for some time later; form, roundish oblate; size, small to medium; color, yellowish red, shading to deep red; skin, tender; seeds, few; flavor, sweet; quality, very good.

Sooty. Introduced from Danville, Ind., where it ripens during October; form, oblong ovate; size, large; color, dull yellow, blushed in the sun; skin, rather tough; seeds, few; quality, very good.

Winech. Introduced from Pennsylvania, where it ripens during October and November; form, roundish oblate; size, medium; color, dull yellow, splashed with red; flavor, rich and sweet; quality, very good.



Dup.



FARMERS' BULLETIN



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USES OF SORGHUM GRAIN.

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INTRODUCTION.

The grain sorghums are made up of several different groups of sorghums which produce good yields of feeding grain. Among these groups are kafir, milo, durra, and kaoliang. In most of them the forage value is not large. The kafirs, however, have a comparatively high forage value because of their semijuicy stems and large and abundant leaves.

The sorghums are of recent introduction. The kafirs and durras were brought to this country about 40 years ago, milo about 30 years ago, and the best kaoliang about 10 years ago. However, the grain sorghums first became important in this country about 10 years ago. Kafir was brought to Kansas about 1890 and spread rapidly to the South and West. Milo was brought into Texas about the same time or a little later, and spread rapidly to the West and more slowly to the North.

These crops first attracted attention because they were drought resistant. When the first wave of settlement swept across the southern Great Plains there was much difficulty in obtaining suitable

NOTE.—This bulletin is suitable for distribution in the southern part of the Great Plains area.

crops. Corn was found to be well suited to the more humid parts and the more favorable seasons; in the drier parts of the Plains and in dry seasons it failed.

All members of the sorghum family were found to be very drought resistant; in the favorable seasons they made profitable yields and in dry seasons they were much better than corn. The grain sorghums, therefore, have come to be extensively used in place of corn for grain production, especially in the drier districts.

SORGHUM GRAIN FOR FEED AND FOOD.

The two natural uses for these grains are as feed for farm stock and food for people. The value of any feeding stuff or foodstuff depends on at least four factors. The first is the chemical composition, which tells what and how much of different food substances each contains.

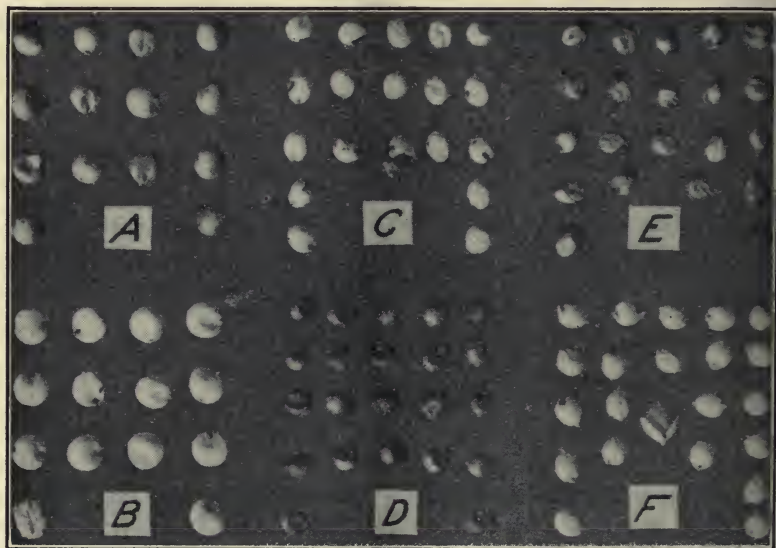


FIG. 1.—Seeds of grain sorghums: A, Milo; B, White durra; C, Blackhull kafir; D, Red kafir; E, Brown kaoliang; F, shallu. (Slightly reduced.)

The second is digestibility, or how easily or completely it is digested, which may determine how profitably it can be fed. The third is palatability, or how well it is liked, which may determine how successfully it can be fed. The fourth is preparation and storage, how readily and safely it can be handled and shipped.

CHEMICAL COMPOSITION OF SORGHUM GRAINS.

The results of a large number of chemical analyses are shown in Table I. This work was done cooperatively, the Office of Cereal Investigations growing the crops and furnishing the samples and the Plant Chemical Laboratory of the Bureau of Chemistry making the analyses. The crops were all grown at the Amarillo Cereal Field Station, at Amarillo, Tex. The varieties (fig. 1) analyzed were mil-

Dwarf milo, feterita, Blackhull kafir, Dwarf Blackhull kafir, Red
 ir, and shallu.

TABLE I.—Averages of chemical analyses¹ of air-dry samples of grain-sorghum varieties grown at the Amarillo Cereal Field Station, for each of the years stated.

Crop and year.	Number of analyses.	Water.	Ash.	Nitrogen.	Protein.	Carbohydrates.	Fat.	Fiber.	Weight per—	
									1,000 kernels.	Bushel.
									Grams.	Lbs.
Dwarf milo:										
1908.....	8	8.76	1.69	1.79	11.20	73.75	3.20	1.40	37.2	57.6
1909.....	11	8.34	1.66	2.13	13.30	72.23	2.99	1.48	36.7	57.9
1910.....	11	8.54	1.70	2.15	13.47	71.61	3.14	1.54	36.2	58.0
1911.....	19	9.92	1.48	1.78	11.08	72.69	3.34	1.49	35.6	58.5
1912.....	18	10.02	1.66	2.17	13.60	70.17	3.04	1.47	35.7	58.2
Average.....	67	9.32	1.62	2.01	12.54	71.89	3.15	1.48	36.1	58.1
Dwarf Blackhull kafir:										
1908.....	6	8.68	1.66	1.81	11.34	73.57	3.33	1.42	32.8	57.6
1909.....	5	8.56	1.57	2.10	13.10	71.91	3.37	1.49	34.4	58.0
1910.....	6	8.34	1.77	2.10	13.17	71.80	3.32	1.60	33.5	57.8
1911.....	18	9.40	1.58	1.62	10.55	73.72	3.32	1.43	29.5	58.6
1912.....	20	10.10	1.63	2.13	13.30	70.25	3.19	1.48	31.4	58.1
Average.....	55	9.38	1.63	1.92	12.16	72.09	3.27	1.47	31.4	58.2
Feterita:										
1908.....	1	8.72	1.58	2.08	13.00	72.08	3.32	1.30	35.5	56.9
1909.....	1	8.94	1.60	2.24	14.00	70.72	3.27	1.47	34.8	55.8
1910.....	1	8.48	1.78	2.26	14.12	70.91	3.21	1.50	27.1	55.2
1911.....	1	10.46	2.06	2.26	14.13	68.80	2.98	1.57	27.6	54.7
1912.....	4	10.01	1.69	2.27	14.20	69.97	2.61	1.50	33.2	56.2
Average.....	8	9.53	1.72	2.24	14.00	70.32	2.90	1.48	32.2	55.9
Blackhull kafir:										
1908.....	13	8.90	1.64	1.98	12.42	71.85	3.59	1.60	25.0	58.8
1909.....	16	9.91	1.84	2.38	14.90	68.47	3.44	1.44	22.3	58.1
1910.....	16	8.84	1.84	2.35	14.70	69.28	3.67	1.67	19.5	57.5
1911.....	17	10.18	1.77	2.19	13.73	69.17	3.49	1.66	22.5	57.7
1912.....	16	9.90	1.83	2.31	14.40	69.14	3.15	1.52	19.4	58.2
Average.....	78	9.58	1.78	2.25	14.10	69.49	3.47	1.58	21.6	58.0
Dwarf Blackhull kafir:										
1908.....	1	9.38	1.57	1.81	11.31	72.65	3.55	1.54	22.1	58.5
1909.....	2	9.82	1.74	2.14	13.40	70.25	3.39	1.40	18.6	59.6
1910.....	2	8.97	1.85	2.20	13.78	70.02	3.58	1.80	13.8	57.4
1911.....	2	10.82	1.59	1.95	12.21	70.94	3.06	1.38	17.4	59.3
1912.....	6	10.13	1.69	2.13	13.30	70.17	3.12	1.53	15.7	58.7
Average.....	13	9.95	1.70	2.09	13.09	70.49	3.25	1.52	16.6	58.7
Shallu:										
1908.....	4	9.12	1.57	1.81	11.31	73.18	3.41	1.41	22.7	59.3
1909.....	9	9.59	1.74	2.00	12.50	71.39	3.40	1.38	19.0	59.4
1910.....	9	8.89	1.76	1.90	11.88	72.84	3.01	1.62	16.6	57.7
1911.....	7	10.27	1.61	1.81	11.32	72.29	3.05	1.46	19.7	58.1
1912.....	8	9.87	1.87	2.01	12.50	70.99	3.05	1.64	16.8	57.7
Average.....	37	9.56	1.73	1.92	12.01	72.03	3.16	1.51	18.5	58.3
Shallu:										
1911.....	4	10.84	1.87	2.13	13.32	68.51	3.72	1.74	14.9	58.9
1912.....	6	10.07	2.05	2.62	16.40	64.08	3.67	2.05	15.3	57.2
Average.....	10	10.38	1.98	2.42	15.17	66.86	3.69	1.92	15.1	57.9

The analyses were made by the Plant Chemical Laboratory of the Bureau of Chemistry, U. S. Department of Agriculture.

A study of Table I shows that there are no striking differences in chemical content among the varieties tested. The differences from year to year in any one variety are nearly as great as the differences between varieties. However, it is noted that feterita is higher in

protein content, lower in fat content, and a little lower in starch content than is milo (fig. 2), to which it is most similar. In protein content it is more like the Blackhull kafirs, though having less than these.

The milos and Blackhull kafirs are the staple grain-sorghum crops. When these are directly compared it is seen that the kafirs have more protein and less starch than the milos, with about the same quantity of fat. The analyses of shallu are not numerous enough to be conclusive. They seem to show, however, that it is relatively high in protein and fat and comparatively low in starch.

In Table II the averages are grouped for greater convenience of study. The averages of all analyses for each variety are shown. The analyses of all samples of both varieties of milo, and of both



FIG. 2.—Milo seeds, hulled and unhulled, and a small branch of a head. (Natural size.)

varieties of Blackhull kafir, and then of all three varieties of kafir averaged. Finally, the average of the analyses of all varieties of grain sorghums—a total of 268 samples—is given.

Since these grains come into direct competition with corn for feeding purposes, the analyses of 86 samples of dent corn are given for comparison. These samples of corn were grown in different years in different States and were analyzed in various places. They are not exactly comparable, therefore, with the analyses of the sorghums, which were all grown at one place and analyzed in one laboratory. However, they probably are fairly representative of the average corn used for feeding purposes, and therefore may be compared with the analyses of the sorghums. This comparison shows some small differences.

The sorghums are seen to be distinctly higher in protein content than corn. The carbohydrate content is practically the same. The fat content is much lower in the grain sorghums, while the fiber content is also somewhat lower. Since fat is really a concentrated

bohydrate, this shows corn to be distinctly richer in carbohydrates, or starchy matter, and the sorghums definitely better in protein content.

TABLE II.—Averages of chemical analyses¹ of air-dry samples of various grain-sorghum varieties grown at the Amarillo Cereal Field Station, Amarillo, Tex., 1908 to 1912, inclusive, with the average for each group in all years and the average for 268 analyses in all crops combined in all years, compared with 86 analyses of dent corn.

Sample.	Number of analyses.	Water.	Ash.	Nitrogen.	Protein.	Carbohydrates.	Fat.	Fiber.	Weight per—	
									1,000 kernels.	Bushel.
									<i>Grams.</i>	<i>Lbs.</i>
Milo.....	67	9.32	1.62	2.01	12.54	71.89	3.15	1.48	36.1	58.1
	55	9.38	1.63	1.92	12.16	72.09	3.27	1.47	31.4	58.2
Average of 2 milos.	122	9.35	1.62	1.97	12.37	71.97	3.21	1.48	34.0	58.1
Kafir.....	8	9.58	1.72	2.24	14.00	70.32	2.90	1.48	32.2	55.9
Blackhull kafir.....	78	9.58	1.78	2.25	14.10	69.49	3.47	1.58	21.6	58.0
	13	9.95	1.70	2.09	13.09	70.49	3.25	1.52	16.6	58.7
Average of 2 kafirs.	91	9.63	1.77	2.23	13.95	66.65	3.43	1.57	20.9	58.1
Kafir.....	37	9.56	1.73	1.92	12.01	72.03	3.16	1.51	18.5	58.3
Average of 3 kafirs.	128	9.61	1.76	2.14	13.39	70.33	3.35	1.55	20.1	58.2
Dent corn.....	10	10.38	1.98	2.42	15.17	66.86	3.69	1.92	15.1	57.9
Average of all varieties.	268	9.52	1.70	2.07	13.01	70.95	3.29	1.53	26.6	58.1
Dent corn ²	86	10.60	1.50		10.30	70.40	5.00	2.20		

¹The analyses were made by the Plant-Chemical Laboratory of the Bureau of Chemistry, U. S. Department of Agriculture.

²Shown only in the years 1911 and 1912.

³Winters and Winton, Compilation of Analyses of American Feeding Stuffs. U. S. Dept. Agr., Office Experiment Stations Bul. 11, 1892.

DIGESTIBILITY OF THE SORGHUM GRAINS.

Several experiments have been conducted during the past 15 years to determine the digestibility of sorghum grains, especially kafir. Most of these experiments have been made with stock, chiefly cattle and hogs, but some have used human subjects.

In general, all the results agree in showing that the starch of the sorghum grains is less digestible than that of corn. It is found that the difference averages about 10 per cent. In other words, the sorghum grains have about 90 per cent of the feeding value of corn. In the early experiments a difference considerably greater than 10 per cent sometimes was recorded. Later experiments tend to show that the difference really is not so large as this figure.

Let 10 per cent be allowed as a fair average of the difference in feeding value. The grain sorghums are shown still to be profitable feeding crops when the price is not more than 90 per cent of the price of corn of the same grade.

If the farmer growing kafir and milo is at a disadvantage in the relative value of his grain he has several advantages in compensation. His crop is grown on cheaper land. He is close to the source

of cottonseed meal as a protein concentrate for his feeding ration. If he is himself the feeder, his stock are fed under milder winter conditions than those of the corn-belt feeder.

PALATABILITY OF THE SORGHUM GRAINS.

There seems no need for discussion of this question. Stock and poultry of all kinds eat the sorghum grains readily when they are of good quality. Moldy or wormy heads or musty and weeviled grain will not be palatable any more than corn, oats, or barley in the same

condition. Owing to the hardness of the kernels, it is always desirable to grind or chop them for feeding.

For human food the meal of these grains has a somewhat distinctive flavor. This is not nearly as different from that of corn as, for instance, the flavor of buckwheat is from that of wheat flour.

PREPARATION AND STORAGE.

PREPARATION.

The grain-sorghum crop is harvested in three general ways. It is cut with the corn



FIG. 3.—Milo heads; one pendent, one erect.

binder, or headed with the kafir header or ordinary grain header, or it is headed by hand.

That which is bound may be fed in the bundle or shocked and headed later in the season or as needed. Feeding in the bundle usually is practiced only as a maintenance ration for horses not at work or cattle not producing milk or being fattened for market.

One problem in the handling of grain sorghum when the crop is headed is the proper curing and storage of the heads. Usually these heads are thrown out in long, shallow piles to cure, if the crop is at all green or if it is wet from recent rains. This is a satisfactory way of curing in favorable weather, if the piles are not made too large.

If the crop is fully mature and thoroughly dry the heads may be hauled direct to the granary or crib. This can be done more safely in the case of milo and feterita than in the case of kafir. The short, broad heads of milo (fig. 3), with their somewhat crooked stems, do not pack tightly together. The kafir heads (fig. 4) are more slender, and the straight stem is still green and somewhat juicy when the grain is ripe. This

crop is more likely to rot, therefore, when stored in quantity.

Headed kafir or milo may be sold or stored in the head, or the heads may be bound into head chops, or they may be thrashed and only the grain used. The thrashed grain should never be fed whole, but always ground coarsely, in which form it is known as kafir or milo chops.

STORAGE.

One of the problems in connection with the use of these grains is in the storage of the heads or thrashed grain or

chops. Like corn, they may get out of condition and become damaged if special care is not taken. Cribs and bins used for storing the heads should be well ventilated. They should be examined from time to time to make sure that the contents are not being damaged by eating.

The grain should always be allowed to become thoroughly cured before thrashing or grinding. In ordinary thrashing a high percentage of the grain is cracked. Cracked grain will absorb moisture and spoil more readily than whole grain. Great care should be taken to crack as little as possible in thrashing. The proportion of cracked kernels can be much decreased by reducing the speed of the cylinder by removing part of the concaves.



FIG. 4.—Heads of four varieties of kafir: A, White kafir; B, Guinea kafir (Guinea corn of the West Indies); C, Blackhull kafir; D, Red kafir. (About one-fifth natural size.)

The grain should be thoroughly dry before being stored in bins and it should be watched while storage continues. The average moisture content of sorghum grain is not as high as that of corn. This is due partly, perhaps, to its being produced in dry districts. Nevertheless, when the water content is above normal the grain will heat readily if not carefully handled. Excessive moisture content is probably the most common cause of damage.

USE FOR HUMAN FOOD.

Ever since these crops were first grown in the dry-land West they have been used to some extent for human food. Ground at the local gristmill, they have been turned into batter-cakes in the farm kitchen on many a winter morning. In the making of corn bread or johnny-cake they have taken the place of corn meal with satisfaction to the consumer. The grain also may be used successfully for pop corn.

Only in recent years, however, have scientific tests been made to determine their value in the human diet. The results of these experiments show that the meal of kafir and milo is comparable with corn meal. It can be used alone or in mixtures with wheat flour in varying proportions in such ways as corn meal is used.

Owing to the absence of gluten in the protein, grain-sorghum flour can not be used for making raised bread. It should not be ground into flour, therefore, but into meal instead. In this form it can be used for pancakes, corn bread, mush, puddings, etc., just as corn meal is used. It can also be mixed with wheat flour in the same way as corn meal, where desired.

In order to compete successfully with corn meal as a human food it should have one or more of four different qualities. These are (1) greater food value, (2) a distinct and attractive flavor, (3) a different range of usefulness, or (4) lower cost. It does not appear that grain sorghum possesses any one of these four to a marked degree. Chemical analysis does not indicate a higher food value, and lower digestibility disproves it. The flavor is rather distinct, but apparently it is not sufficiently attractive to be remembered, craved and sought. As has just been seen, its uses are much the same as those of corn meal. Finally, there is no reason to believe that it can be produced much more cheaply in proportion to its actual value.

A varied diet is desirable. Sorghum grain can be and should be used for human food. Doubtless it will be used to some extent whenever it can be produced and sold at a figure which will make it profitable to dealer and consumer alike. It seems, however, that no large new demand is likely to be created for this crop by reason of its use as human food.

INCREASING THE USE OF GRAIN SORGHUMS.

As has been seen, the acreage devoted to these crops has been growing rapidly in recent years. While the annual increase of the present and future may not average as large as it was in 1912 and 1913, it is likely to be rather steady. It is probable that the acreage for 1915 has been very largely increased, especially in the cotton-producing States of Oklahoma and Texas. Owing to the very low price of cotton and the carrying over of a considerable part of the 1914 crop, there has been a marked reduction in cotton acreage. Part of the area thus released from cotton has been devoted to winter and spring grains. Part of it will be devoted to summer forage crops. Another, and a considerable part of it in the two States named, will be sown to the grain sorghums. If seasonal conditions are favorable, there should result a bumper crop of these grains in the fall of 1915. The problem of the profitable disposal of such a crop merits careful attention.

GRAIN SORGHUMS FOR FEEDING TO STOCK.

In the early years of grain-sorghum production the crop was wholly used on the farms where it was grown. As the merits of these crops became better known and the acreage increased, there has been a growing surplus to dispose of commercially. There has always been some difficulty in marketing this surplus promptly at profitable prices.

The value of this grain for feeding in beef, milk, pork, and egg production is not yet fully recognized. In some seasons it has been almost a drug on the market until the following spring, when the growing scarcity and increasing price of feeding corn turned attention toward it. If it is to be in any sense the money crop of certain districts it must be readily and profitably convertible into cash. This means that the surplus must be able to move freely, at good prices, soon after being thrashed.

Since it is a feeding grain, it is reasonable to believe that it can be sold as profitably where it is grown as elsewhere, other things being equal. Freight charges on the crop shipments are thereby avoided, as also the wagon haul from farm to railroad. It is much more readily and cheaply transported to market in the form of beef or pork.

It seems especially unfortunate that these crops should be grown in the midst of the greatest stock-producing section of the country and yet not be fed on the farms where they and the stock are grown. To reverse the statement, both cattle for feeding and grain sorghums for feed are raised extensively in the southern Plains area, but the cattle are shipped out to be fed elsewhere. In this direction lies the greatest opportunity for expansion in their use. It is realized that

the financing of extensive stock-feeding operations is a slow and somewhat difficult matter. The start has been made, however, and progress should be aided and encouraged by every commercial agency concerned.

At the present time a large part of the cattle grown in the grain sorghum-producing districts are fed in corn-belt States farther north and east. They are fed likewise on corn. As conditions now exist the cattle proceed to market on a feeding-in-transit rate. If sorghum grain is to be used largely in feeding these cattle, it must follow them by rail to the feeding districts. There is no feeding-in-transit rate for grain sorghums. They must not only compete with corn in feeding favor, but must bear heavier transportation rates because of the longer distances from which they come. This can be remedied only by encouraging local feeding.

The recent rapid increase in the number of silos in the States of Oklahoma and Texas will be a direct aid to cattle-feeding operations. The combination of home-grown silage and feeding grain, with readily accessible cottonseed meal, ought to aid in making feeding profitable in the grain-sorghum belt.

FINDING A MARKET ABROAD FOR GRAIN SORGHUMS.

One other factor in the situation should not be overlooked. This is the possibility of developing a larger export trade in these grains. Occasional cargoes now leave Galveston or New Orleans for European ports. Very little has been done, however, to stimulate this line of trade expansion.

For several years investigations have been conducted in Germany to determine the feeding value of grains very similar to these. It will be remembered that most of the grain sorghums are of African origin. Various sorghum crops are grown extensively in the German East African colonies. The investigations in Germany were started in connection with the development of this industry in those colonies.

Germany and other European countries are importers of enormous quantities of American feeding grains. This is likely to continue in spite of colonial developments of this kind. If the facts concerning the value and profitable use of American grain sorghums can be brought to the attention of exporters here and importers abroad, a considerable demand for these crops ought readily to result. Fortunately, the producing States are situated fairly well for getting the crop to the Gulf coast for ocean shipment.

GRAIN SORGHUMS FOR FEEDING TO POULTRY.

The sorghum grains, especially Blackhull kafir, are excellently adapted for poultry feed. In size they are small enough so that they are readily fed without cracking or crushing.

An investigation made in 1908 showed more than 100 firms engaged in the manufacture of over 200 brands of poultry feed. Figures furnished at that time by 33 of these firms showed an annual output of about 30,000 tons of these products. Approximately one-third of this quantity, or 10,000 tons, consisted of the seed of Blackhull kafir. This was used mostly in mixture with other grains, such as corn, wheat, screenings, etc. It probably is a safe estimate that kafir or kafir grain-sorghum seed forms fully 25 per cent of the prepared poultry feed sold in this country.

There is a steady demand for these grains in the manufacture of poultry feed. When the crop in this country has been short, similar varieties have been imported from as far away as India and China. Such importations occurred four years ago as a result of the short crop of 1909. The poultry industry is steadily increasing in this country. It is probable that kafir grain would form a still larger proportion of the total poultry feed manufactured if it were always available at satisfactory prices. This avenue for extending the use of these grains should not be neglected.

ACREAGE AND VALUE OF GRAIN SORGHUMS.

At the present time very large acreages of grain sorghums are grown in the States of Kansas, Oklahoma, and Texas. Smaller quantities are raised in New Mexico, Colorado, and California. The

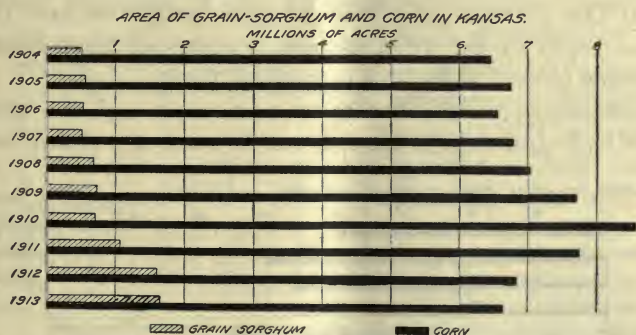


FIG. 5.—Graphic comparison of the area in millions of acres of grain sorghum and of corn in Kansas for the 10 years 1904-1913, inclusive.

total acreage is not known, because no complete statistics of these crops are taken. Estimates based on such statistics as are available indicate that three or four million acres of grain sorghums are grown annually in the three States first mentioned. It is certain that the acreage of grain sorghums has increased enormously in the last two or three years, while that of corn has decreased.

Figures 5 to 12, inclusive, are diagrams, or graphs, showing the comparative acreage and acre value of grain sorghums and corn in Kansas and Oklahoma. This is shown first for each State as a whole.

The same facts are then shown for the western part of each State. For this purpose the counties lying wholly west of the ninety-eighth meridian are chosen in each case.

In Kansas this includes the counties, from north to south, of Smith, Osborne, Russell, Barton, Stafford, Pratt, and Barber, and all lying

AREA OF GRAIN SORGHUM AND CORN IN THE WESTERN HALF OF KANSAS.

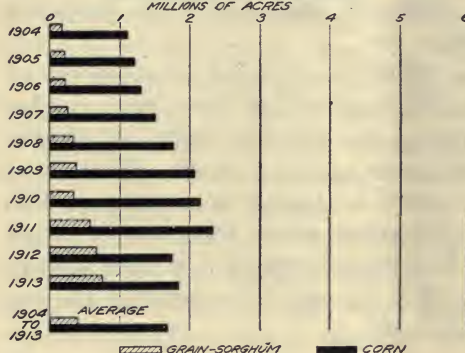


FIG. 6.—Graphic comparison of the area in millions of acres of grain sorghum and of corn in the 46 counties comprising the western half of Kansas and lying wholly west of the ninety-eighth meridian, for the 10 years 1904-1913, inclusive, and average area for the 10-year period.

corn. (3) The increase in acreage of grain sorghums over corn has been most rapid in the drier western portions of these States, and the difference in acre value also is greatest there.

The coincidence of the declining corn area and the increasing acreage of kafir and milo in Kansas can be seen at a glance in figure

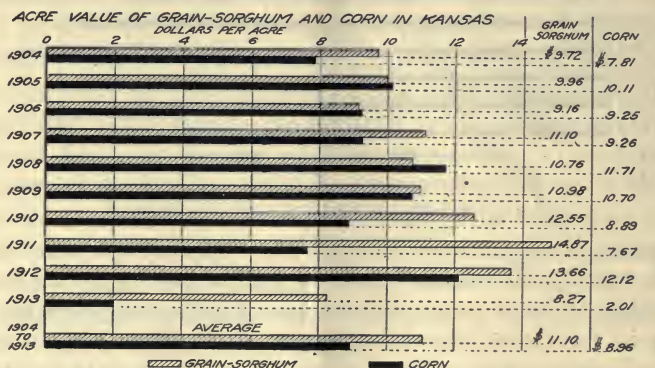


FIG. 7.—Graphic comparison of the annual acre value in dollars per acre of grain sorghum and of corn in Kansas for the 10 years 1904-1913, inclusive, and average acre value for the 10-year period.

5 and 6. Figure 5 tells the story for Kansas as a whole and figure 6 for the 46 counties comprising the western half. In this State the grain-sorghum area jumped to 1,093,000 acres in 1911, 1,605,000

acres in 1912, and 1,633,000 acres in 1913. The maximum area devoted to corn in Kansas was 8,590,000 acres grown in 1910. In 1911 and 1912 the area decreased nearly 1,000,000 acres a year.

What caused the rapid change in comparative acreage? A growing knowledge of comparative acre values? Mere acres count for little unless they produce profits. Figure 7 shows the acre value of both crops in Kansas during the last 10 years. For the entire State the average acre value of kafir and milo was \$2.14 greater than that of corn. The production of these crops is also more regular and evenly distributed. These statistics, taken from the reports of the Kansas State Board of Agriculture, are not wholly fair to corn, however. They include the value of both grain and stover in grain

sorghums, but only the grain value of the corn. If the stover value of corn were included, the average values would be more nearly equal.

While this was being done in Kansas, Oklahoma also was making history. Figure 8 tells the story of Oklahoma's acres, while figure 9 shows what happened in the 21 counties contained in the western

third of the State. She produced 625,000 acres of grain sorghums in 1910 and 873,000 acres in 1911, an increase of a quarter million acres. No data for 1912 and 1913 are available, but there is every reason to believe, from the vigorous campaign waged, that the increase was proportional to that in Kansas. Oklahoma reached her maximum corn area in 1909 with 5,135,000 acres. In 1910

and 1911 the decline was at the rate of more than a million acres a year, as shown in figure 8.

Figure 10 shows the acre value of both crops in Oklahoma for eight years, beginning in 1904. Corn has an average advantage of \$2.26 per acre for the period. This reversal of the Kansas figures is due to three or four things which profit corn. Oklahoma lies in a more southerly latitude than Kansas. The Oklahoma statistics include

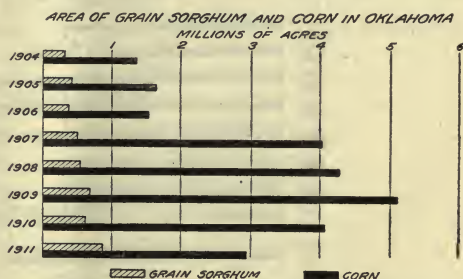


FIG. 8.—Graphic comparison of the area in millions of acres of grain sorghum and of corn in Oklahoma for the 8 years 1904-1911, inclusive.

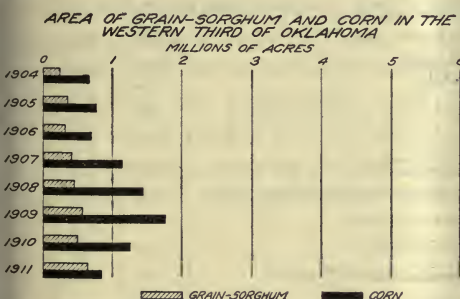


FIG. 9.—Graphic comparison of the annual area in millions of acres of grain sorghum and of corn in the 21 counties comprising the western third of Oklahoma and lying wholly west of the ninety-eighth meridian, for the 8 years 1904-1911, inclusive.

the stover value of only a small part of the grain sorghum. The grain sorghums are largely restricted to the drier western third Oklahoma. (See fig. 9.) The very unfavorable season of 1913 not included, for lack of data.

Half of Kansas, 46 of the 105 counties, lies west of the ninety-eighth meridian. Figure 6 shows the area of grain sorghum and co

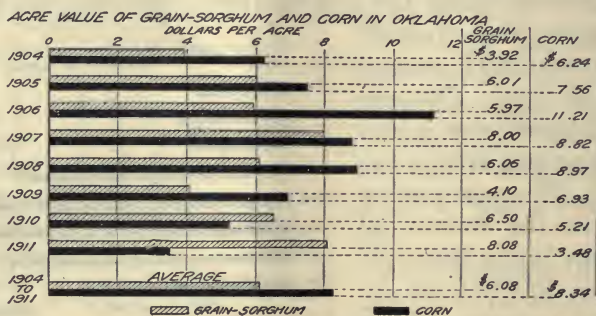


FIG. 10.—Graphic comparison of the annual acre value in dollars per acre of grain sorghum and of corn Oklahoma for the 8 years 1904–1911, inclusive, and average acre value for the 8-year period.

in those counties. Nineteen of them already grow more kafir an milo than corn. The average acre value for this area, as shown i figure 7, proves the grain sorghum to be the more profitable crop.

A comparison of figure 6 with figure 5 shows that fully half of th Kansas grain sorghum is grown in the eastern half of the State. Th

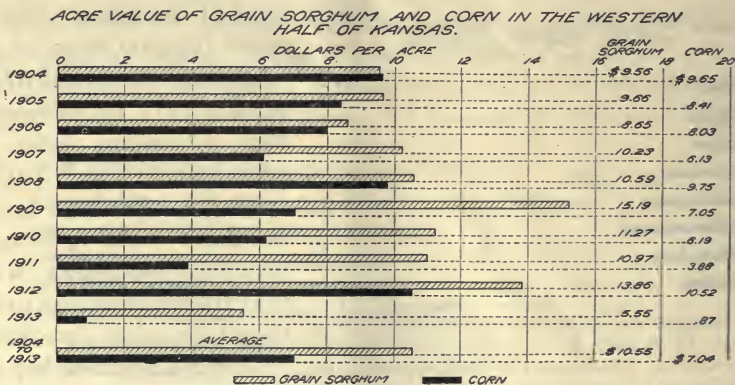


FIG. 11.—Graphic comparison of the annua lace value in dollars per acre of grain sorghum and of corn i the 46 counties comprising the western half of Kansas and lying wholly west of the ninety-eighth meridian, for the 10 years 1904–1913, inclusive, and average acre value for the 10-year period.

acre value for the entire State indicates, moreover, that it pays t grow it in eastern Kansas, at least on the uplands.

Similarly, one-third of Oklahoma, containing 21 counties, lies wes of the ninety-eighth meridian. Figure 9 shows the acreage in thi area of the two crops under discussion. Nine of these counties in 191 grew more kafir and milo than corn. Figure 12 tells why they did i

and why more of them probably were doing it in 1913. In sharp contrast to Kansas, a comparison of figure 9 and figure 8 shows only about one-fifth of the grain-sorghum crop grown in the eastern two-thirds of the State. When the acre values given in figure 10 for all Oklahoma and in figure 12 for the western third are considered, there is developed a presumption that it would be very profitable to grow kafir and milo farther east in Oklahoma.

Meanwhile what of Texas, the great dry-farming empire of the South? It is known that during the years when the kafir industry

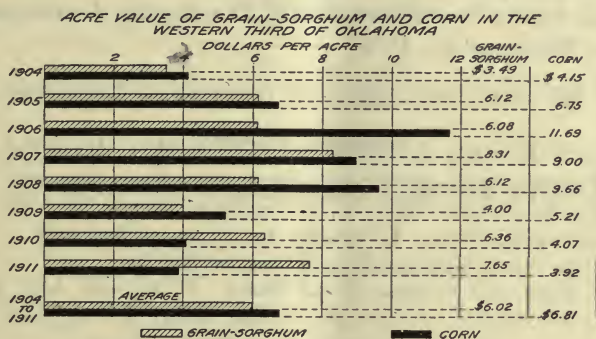


FIG. 12.—Graphic comparison of the annual acre value in dollars per acre of grain sorghum and of corn in the 21 counties comprising the western third of Oklahoma and lying wholly west of the ninety-eighth meridian, for the 8 years 1904-1911, inclusive, and average acre value for the 8-year period.

was developing in Kansas, milo had been carried into Texas by westward-faring emigrants. Gradually it became established on the farms and ranches of the drier western portions of the State. No statistical data are to be had, but it is known that it increased steadily and also that the kafirs were soon introduced and became popular. There is every reason to believe that the area devoted to these two crops in Texas has more than equaled the area grown in Kansas, at least until the recent enormous increase.

PUBLICATIONS ON GRAIN SORGHUMS.

In the list that follows, those publications to which no price attached may be obtained without charge upon application to the Secretary of the United States Department of Agriculture; publications having a price attached may be obtained by remitting the stated sum to the Superintendent of Documents, Government Printing Office, Washington, D. C.

UNITED STATES DEPARTMENT OF AGRICULTURE, WASHINGTON, D. C.

FARMERS' BULLETINS.

The Nonsaccharine Sorghums. Farmers' Bul. 288. Paper, 5 cents.
Milo as a Dry-Land Grain Crop. U. S. Dept. Agr., Farmers' Bul. 322.
Better Grain-Sorghum Crops. U. S. Dept. Agr., Farmers' Bul. 448.
Kafir as a Grain Crop. U. S. Dept. Agr., Farmers' Bul. 552.
Use of Corn, Kafir, and Cowpeas in the Home. U. S. Dept. Agr., Farmers' Bul. 559.

BUREAU OF PLANT INDUSTRY CIRCULARS.

Feterita, a New Variety of Sorghum. U. S. Dept. Agr., Bur. Plant Indus. Circ. 122-0.
Paper, 5 cents.
Three Much-Misrepresented Sorghums. U. S. Dept. Agr., Bur. Plant Indus. Circ. 5.
Paper, 5 cents.

BUREAU OF PLANT INDUSTRY BULLETINS.

The History and Distribution of Sorghum. U. S. Dept. Agr., Bur. Plant Indus. Bul. 175. Paper, 10 cents.
The Importance and Improvement of the Grain Sorghums. U. S. Dept. Agr., Bur. Plant Indus. Bul. 203. Paper, 10 cents.
Grain-Sorghum Production in the San Antonio Region of Texas. U. S. Dept. Agr., Bur. Plant Indus. Bul. 237. Paper, 5 cents.
The Kaoliangs: A New Group of Grain Sorghums. U. S. Dept. Agr., Bur. Plant Indus. Bul. 253. Paper, 15 cents.
Cereal Experiments in the Texas Panhandle. U. S. Dept. Agr., Bur. Plant Indus. Bul. 233.

BUREAU OF CHEMISTRY BULLETIN.

The Feeding Value of Cereals as Calculated from Chemical Analyses. U. S. Dept. Agr., Bur. Chem. Bul. 120. 10 cents.

YEARBOOK SEPARATE.

The Grain Sorghums: Immigrant Crops That Have Made Good. U. S. Dept. Agr. Yearbook (1913) Separate 625.

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UNITED STATES DEPARTMENT OF AGRICULTURE



FARMERS' BULLETIN



WASHINGTON, D. C.

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SEPTEMBER 18, 1915

Contribution from the Bureau of Plant Industry, Wm. A. Taylor, Chief.

ERADICATION OF FERNS FROM PASTURE LANDS IN THE EASTERN UNITED STATES.

By H. R. Cox,
Agriculturist, Office of Farm Management.

KINDS OF FERNS THAT ARE WEEDS AND AREAS INFESTED.¹

There are nearly 7,500 recognized species of ferns in the world, of which number over 200 are known to be native to the United States. A few species have become weed pests in this country, and it is to a discussion of the control of these weedy ferns that this bulletin is devoted.

The parts of the United States in which ferns are bad weeds are, principally, (1) the hill country of the Northeastern States and the higher portions of the Appalachian Mountain region as far south as Georgia, and (2) the Pacific coast country west of the Cascade Mountains. In the former region, which is the area covered by this bulletin, the principal weedy ferns are the hay-scented fern (*Dennstaedtia punctilobula*) and the brake (*Pteris aquilina*, formerly known as *Pteridium aquilinum*). Both kinds are sometimes called brakes, although this term is properly applied only to the latter species. In the Pacific coast section the brake is the most common weedy fern.

Several other species in the eastern region are sometimes annoying, but they occur largely in low and moist places and do not give much trouble on good pasture land. They are principally the cinnamon fern (*Osmunda cinnamomea*), the marsh fern (*Orthopteris thelypteris*), and the sensitive fern (*Onoclea sensibilis*).

¹ The writer is indebted to Mr. J. S. Cotton, of the Office of Farm Management, for valuable suggestions in making the experiments described in this bulletin.

NOTE.—This bulletin will be of interest to farmers in the hill country of the Northeastern States and the higher portions of the Appalachian Mountain region farther south.

SCOPE OF THIS BULLETIN.

This publication deals only with fern eradication in the Eastern States. Although the experiments here recorded were made with the hay-scented fern, there is every reason to believe that the methods found useful against this species would be equally applicable to the brake. It should be understood, however, that the fern referred to in the following pages is the hay-scented fern.

HABITS OF GROWTH OF THE WEEDY FERNS.

THE HAY-SCENTED FERN.



FIG. 1.—The hay-scented fern.

The hay-scented fern (fig. 1) has a perennial, very slender rootstock one-eighth to three-sixteenths of an inch in diameter, extensively creeping below ground parallel to the surface. From the rootstocks arise at short intervals the fronds, or leaves, of the plant. These fronds are 1 to 3 feet high and 5 to 9 inches wide when mature. The fruit dots occurring on the margin of the leaf bear the spores which are comparable to the seeds of seed-bearing plants.

This kind of fern grows in patches or clumps (fig. 2), the surfaces of which are raised above the rest of the land and are soft and spongy, consisting of an accumulation of dead fern and forest leaves. In these clumps the fern leaves grow so thickly that young grass has no opportunity to work in. Even if grass could get a start in the clumps, it would be smothered out when the fern leaves fall over and die on the coming of cold weather.

The hay-scented fern is rather particular as to location. It thrives in places partially protected from the sun's rays, such as northern, eastern, and western slopes, or in areas close to stone walls or trees. It is noteworthy that this fern is not found in places that are much trodden. Either the plants have been driven out by the trampling of animals or the soil is so compact that the fern can not get a start.

THE BRAKE.

The brake (fig. 3) has underground parts similar to those of the hay-scented fern, but the rootstocks are more stout and woody and creep longer distances below the soil surface. The brake also has the same methods of reproduction as the hay-scented fern. The plant

varies much in size; in the Eastern States it is 1 to 3 feet high, but on the Pacific coast it attains a height of 6 to 8 feet. The leaf blades are triangular and umbrella-like, 1 to 4 feet broad, and long and more or less three parted, the larger branches usually twice divided. At maturity the fruiting leaves have a continuous edging of spore cases, which shed the light-brown spores in great quantities.

In the Eastern States the brake is distributed somewhat more generally than the hay-scented fern, not being confined so exclusively to



FIG. 2.—A pasture in southern New York with a characteristic growth of hay-scented ferns.

the hill and mountain country. From its habit of being widely creeping, the brake does not occur in dense, well-defined patches, like the hay-scented fern (fig. 4).

CONTROL OF FERNS IN THE EASTERN STATES.

As the grazing of live stock is a prominent feature in the farming of the eastern region in which ferns are weeds, and as the area of available pasturage has been curtailed by the presence of the ferns, these weeds are looked upon as a serious pest. Moreover, since these lands for the most part are so steep and rocky as to prohibit cultivation, and since the ferns, unlike many other pasture weeds, can not be reduced in number by increasing the vigor and thickening the stand of the pasture grasses, a real problem in weed control is presented.

METHODS ALREADY IN USE.

The methods that have been adopted for eradicating ferns in the Eastern States are cutting or mowing, salting live stock, and cultivation.

CUTTING OR MOWING.

In 1557 Thomas Tusser wrote his "Five Hundred Pointes of Good Husbandrie," in which he said:

In June and in August, as well doth appeere,
Is best to mowe Brakes of all times of the Yeere.



FIG. 3.—The brake.

In 1911 a representative of the United States Department of Agriculture found a farmer in Delaware County, N. Y., who was following the identical method advised by Tusser and had greatly reduced the number of ferns in his pasture (See fig. 5.) This farmer, Mr. W. Thomson, has found that attacking them twice a year greatly reduces the number of ferns, and that if the method is followed for two years in succession most of them disappear.

It is best to make the cutting just previous to the time when the ferns mature their spores. This not only prevents propagation by means of spores but greatly weakens the rootstocks, which are in their most susceptible stage just previous to sporing. As the spores mature during the latter part of June in Delaware County, the proper time to make the first cutting in that region is about the

middle of that month. New leaves spring up immediately, so that one more cutting must be made that season to prevent sporing. The second cutting should be made about the middle of August. It is highly important to observe the precaution that if either of the cuttings is put off until after the spores mature, the plants should not be disturbed during the remainder of that season, since mowing the ferns after the spores ripen seems to scatter the spores a great deal more than when the plants remain undisturbed.

The work of cutting must usually be done by hand (fig. 6), as the land is generally too rough to admit of the use of a mower. In

pasture with an average quantity of fern, one man with a scythe can cover about $2\frac{1}{2}$ acres in a day. The leafstalks are tender and are easily cut with a scythe.

The writer has found a number of farmers in the mountain-pasture district of North Carolina who have successfully used this method of eradicating ferns. The plan seems to be generally accepted as the best in that region.

Burning after cutting.—Mr. Thomson has found that burning over the fern patches after cutting serves as a further check to the pest.



FIG. 4.—A field infested with brakes, near Tacoma, Wash.

After the mowed fern leaves have become dry, fire is started on the windward side of the patch. Not all patches will burn completely, as there are varying quantities of combustible material in the areas. Where a fierce fire has passed over a patch the fern rootstocks are undoubtedly injured to a considerable extent.

SALTING LIVE STOCK IN FERN PATCHES.

Where ferns occupy very small areas on a farm certain methods may be used that would not be economical on a thickly infested piece of land. One of these methods is salting live stock in the fern patches. Dry salt is scattered on the plants when they are moist with rain or

dew. The stock eat and trample the plants in their effort to get the salt. This plan has been successful on at least one farm near Delhi, N. Y. Since the saltings must be rather frequent, the areas treated should be those that are easily accessible.

CULTIVATION.

There is no doubt that cultivation destroys ferns. The difficulty is that the steep and rocky character of the fern-infested land does not permit effective cultivation except on limited areas. Cultivation has been tried on Mr. Thomson's farm with indifferent success. When a piece of pasture was plowed up and put into small grain, followed by seeding to grass, the fern worked in again, so that it is now



FIG. 5.—General view in southern New York, showing land in the foreground on which hay-scented ferns have been eradicated by cutting.

as thick as formerly. Another piece of pasture land was well cultivated in potatoes and afterward seeded to grass. In this piece the fern was slower in working back, but later a fairly good stand of the weed was found. If the cultivation could have been continued for several years, permanent eradication of the fern might have been expected, but the character of the land prevented this treatment.

EXPERIMENTS IN FERN ERADICATION.

Having learned the value of the various methods already in use in controlling ferns, the question arose whether there were any other methods that might be more satisfactorily employed. Spraying with

plant poisons suggested itself as the most promising. Accordingly, experiments were planned in cooperation with Mr. Thomson to compare the value of spraying with cutting, as well as to learn something about the best way of getting a stand of grass and clover on the interested areas. These experiments covered a period of two years, 1912 and 1913.

EXPERIMENTS IN 1912.

The tests were made in two series. Series 1 consisted of spraying to kill the ferns, accompanied by seeding, liming, and fertilizing to encourage a stand of grass. All plats were sprayed twice except one, which was sprayed four times. Series 2 consisted of cutting, also accompanied by seeding, liming, and fertilizing. Each plat was cut



FIG. 6.—Cutting ferns with a scythe on a hillside.

twice. The two sprayings and two cuttings on the various plats were made about the middle of June and August, just preceding spring time.

Sprayed series.—The number of sprayed plats was four, all being uniformly and fairly well set to ferns. The materials used were solutions of common salt, iron sulphate, and arsenite of soda, and in order to make the treatments comparable as to cost the quantities applied to the various plats were of equal value. The sprayer used was a hand bucket pump, which produced a fairly mistlike spray. The entire surface of the plat was treated, the grass as well as the ferns. One-half of each plat was limed and fertilized in June at the rate per acre of 300 pounds of acid phosphate, 150 pounds of muriate of potash, and 2,000 pounds of hydrated lime. The entire surface of

all the plats was seeded to a pasture mixture of grass and clover in August.

Cut series.—The number of cut plats was two. They were both treated alike as to cutting, but one of them was limed and fertilized in June and seeded in August, while the other was merely seeded in August.

EXPERIMENTS OF 1913.

It was the intention to duplicate the treatment of 1912 on all the plats. In the spring of 1913, however, it was evident that the results of spraying on the plats treated with salt and arsenite of soda in 1912 had been so effective that there was not much fern left on which to experiment. Accordingly, two new plats were laid out in 1913 to test the relative merits of these two materials. The quantities used were less, but were equal as to cost, as before. Each plat was sprayed twice.

In addition to these two plats, two small areas of the 1912 sprayed plats were sprayed with the same solutions described above to note their effect on the young seeding of grass and clover.

There were no cutting plats in 1913, as there were numerous places in the fields where the fern had been cut one year and also two years in succession. The cut plats of 1912 were untouched in 1913 in order to note the fighting qualities of the fern in the presence of the new seeding of grass and clover.

CONCLUSIONS FROM EXPERIMENTS AND OBSERVATIONS WITH FERNS.

CUTTING.

Cutting ordinarily is a cheaper method of handling ferns than spraying. With ferns at an average degree of thickness in a pasture a man ought to cover about $2\frac{1}{2}$ acres a day. With labor at \$1.50 the cost of cutting fern is about 60 cents an acre for each cutting, as compared with spraying with salt at about \$1.05.

A further advantage of cutting is that it is less complicated than spraying and requires only the use of a tool with which all farmers are thoroughly familiar.

Still another advantage is that seeding to grass and clover can be made as soon after the first cutting as is desired. After the original stand of ferns is cut down, the subsequent growth is seldom so thick as to prevent young grass working in. The seeding can be done the same year that the work of eradication is started, so that by the following year a good growth of young grass and clover may be expected, which in itself contributes to the reduction of the number of ferns.

SPRAYING.

There is no doubt that salt is the best material for a spray solution against ferns. (See fig. 7.) The iron sulphate was ineffective. Arsenite of soda was effective, but its use involved some risk on account of its poisonous character to man and animals; furthermore, it is rather difficult to obtain except in the larger centers. Salt is very effective, is easily obtainable, and probably exerts an aftereffect favorable to grass. It is also relished by live stock, thus contributing to the destruction of ferns treated with it in pastures to which stock have access.



FIG. 7.—Fields in southeastern New York where the experiments in fern eradication were made. In the immediate foreground is the plat sprayed with salt solution, which accomplished the destruction of nearly all the ferns in one season.

The quantity of salt required to the acre depends, of course, on the thickness of the fern. The smallest amount used in the experiments was 600 pounds to the acre, and this was considerably more than was needed, even though the entire surface of the plats, both the fern and the grass, was treated. As the ferns seldom occupy more than one-third the surface of a pasture, 200 pounds to the acre is usually ample. In these experiments salt was used in almost a saturated solution, that is, 1 pound to about $1\frac{1}{2}$ quarts of water. If desirable, a more dilute solution could be used.

The cost of spraying varies under different conditions and is here only estimated. The difficulty of hauling water up steep slopes is sometimes so great as to make spraying almost prohibitive. After the materials are hauled to the field, the work of spraying proceeds faster than cutting. With ferns of an average degree of thickness a man with a knapsack sprayer ought to cover about 5 acres a day. Assuming that 150 pounds of salt are used to the acre at a cost of one-half cent a pound and that 5 acres are covered in a day with labor worth \$1.50, the cost of spraying with salt is \$1.05 per acre for each application, not including the cost of hauling the materials. As the first spraying is the most expensive in labor and materials, this treatment may cost a little more than the amount mentioned, while the subsequent treatments will probably cost less.

One disadvantage of spraying is that it is a detriment to the growth of young clover. This means that the measures for encouraging the clover to work into the patches occupied by fern should be deferred until after the last spraying has been made. It is probable that the spray does not injure young grass to any great extent.

An advantage of spraying is that it may be employed in situations that are too stony for the efficient use of the scythe (fig. 8). There are also certain other situations where large spraying outfits may be satisfactorily used. Spraying with a barrel pump on a low wagon can sometimes be made more cheaply than with a knapsack outfit.

NUMBER OF TREATMENTS NECESSARY.

Two treatments a year, either spraying or cutting, seem to be about as effective as four, and are to be recommended. Undoubtedly the best time to treat the ferns is just previous to spring, or about the middle of June and the middle of August.

BURNING.

Following a treatment of either spraying or cutting, fire may be started when the vegetation on the surface of the patches is dry. The burning not only kills the shoots that have recently started, but probably affects the vitality of the rootstocks as well. The subsequent growth of young shoots is usually not as vigorous as when the patches are not burned. The burning should be done, of course, before seeding to grass and clover.

HOW LONG SHOULD THE MEASURES OF ERADICATION BE CONTINUED?

It is probably not practicable absolutely to eradicate ferns. After they have been reduced to a minimum the specific methods of destruction may be discontinued, at least until the weeds again become troublesome. The reduction of the number of ferns will give the grass and clover ample opportunity to work in, and this in itself will tend to hold the ferns in check.

GETTING A STAND OF GRASS ON THE FERN PATCHES.

After the fern has been greatly reduced or entirely eradicated, grass is very slow in working into the patches unless certain measures are adopted. Of these measures, scattering grass and clover seed over the patches is the most important one. The stand is better and the growth more vigorous, especially in the case of clover, if lime and fertilizer are applied in addition to the seed.

Seed may be sown either in the early spring or late summer. In these tests the seed was applied at the latter period, that is, during



FIG. 8.—View of a pasture from which ferns have been eradicated, except among rocks and close to the stone fence, by cutting. This pasture presents conditions under which spraying with a salt solution may be the best method of eradication.

August, with excellent results. If the seeding be done at this time the young grass seedlings are less injured, probably by the shading effect of the ferns, than if done in the early spring.

CONTROL OF FERNS IN THE WESTERN STATES.

The brake is fully as serious a weed pest on the Pacific coast as are any of the fern species in the East. A thorough investigation of the fern problem of the Western States has not been made as yet by the Department of Agriculture. There is no doubt, however, that the ferns of that region may be subdued by the same methods used in the East, with certain modifications to meet local conditions, especially in the time of application of the treatments. Owing to the

nature of the land and the kind of farming in vogue on the Pacific coast there are several methods that can probably be used to advantage in that region that can not be employed in the East.

SUMMARY.

Two kinds of ferns have become serious weed pests in the United States, namely, the hay-scented fern and the brake. The two species are troublesome in the hill country of the Northeastern States and in the higher mountain country of the States farther south. On the Pacific coast the brake is the principal weedy fern.

This bulletin deals with the fern problem of the Eastern States. Although the experiments here recorded were made with the hay-scented fern, there is no doubt that the treatment found most effective with that species would apply equally well to the brake. Both kinds are perennials, with running rootstocks which lie more or less parallel to the soil surface.

In most parts of the East where the ferns are weeds the land is so steep and rocky that cultivation is not practicable. It has been found that cutting off the tops close to the soil surface twice a year for two years will kill out nearly all of the ferns. The best times to do the cutting are just previous to spring, or about the middle of June, and the middle of August in southern New York.

Experiments were made in 1912 and 1913 to test the efficacy of spraying as compared with cutting and to learn the best method of obtaining a stand of grass and clover on the fern-infested areas. The spray materials used were solutions of salt, arsenite of soda, and iron sulphate. These materials were used in quantities of equal value.

The results of these tests showed the following facts: Salt is the best spray material of the three. With ferns at an average degree of thickness on the land, 150 pounds of salt dissolved in 60 gallons or more of water to the acre for each application are sufficient. Two sprayings a year are about as effective as four, and are to be recommended. Cutting is somewhat cheaper than spraying. Furthermore, the cutting does not interfere with young clover and grass coming in on the infested patches after the first treatment. This method, therefore, is to be recommended in preference to spraying in most situations. In some places the land is so stony as to interfere with cutting, in which case spraying may be the best method. It was found that scattering seed on the patches where ferns had grown was the most important means of getting a stand of grass and clover, and that liming and fertilizing in addition to the seeding were of considerable benefit.

Dupe



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THE CULTURE OF RICE IN CALIFORNIA.

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INTRODUCTION.

The Office of Cereal Investigations of the Department of Agriculture inaugurated variety tests of rices in the vicinity of Biggs, Cal., in the spring of 1909. These tests were continued in this locality during the season of 1910-11, and during the same period similar tests were made of a smaller number of varieties at several places in the Sacramento and San Joaquin Valleys. These plantings furnished some valuable data on the commercial possibilities of rice culture in California and were largely responsible for the beginning of the industry.

These results were obtained in cooperation with ranchers, but in order that these studies might be enlarged and conducted under conditions more favorable for experimental work, the Biggs Rice Field

NOTE.—This bulletin will be of interest to the rice growers of California.

PROVIDENCE

Station (fig. 1) was established in 1912 through cooperation with the Sacramento Valley Grain Association, an organization composed of ranchers. The station farm, consisting of 57 acres, is located 4 miles northwest of Biggs and is irrigated by gravity from the Feather River through a canal system operated by the Sutter-Butte Canal Co. Its soil is black adobe, which is representative of a considerable acreage of land in the Sacramento Valley upon which rice has been produced commercially for the last three years.

The first commercial crop of rice in California was grown in 1912 on adobe soil in the Sacramento Valley near Biggs. The profits from this crop of 1,400 acres were large. The wide publicity that was given to the possibilities of rice culture on this adobe soil resulted in the sowing of 6,000 acres in 1913. The greater part of this acreage was in Butte County, though there were several small plant-



FIG. 1.—Buildings at the Biggs Rice Field Station.

ings in the San Joaquin Valley. The average yield of 3,200 pounds of grain per acre which was produced by the 1913 crop gave so great an impetus to the industry that in 1914 the area sown in rice was increased to 16,000 acres, adding over \$800,000 to the agricultural wealth of the State.

The recommendations in this bulletin are based upon the results obtained at the Biggs Rice Field Station and a study of the conditions under which rice has been grown in California.

GENERAL REQUIREMENTS OF THE CROP.

Irrigation is an important feature in the culture of rice. Water must be applied continuously and at a uniform depth for many days. To meet these requirements the land which is selected for this crop should be level and underlain by a subsoil that is impervious to water. It is less expensive to prepare a level tract for irrigation than a rolling one, and the cost of maintenance is also less, because there are fewer levees. The impervious stratum of soil should lie near the surface, for a deep soil requires more water and more time for its submergence than a shallow one.

Good drainage is necessary to get the land in condition quickly for harvesting and to prevent water-logging, a condition which unquestionably affects the yield. Clay soils, when easily drained and not too deficient in organic matter seem well suited to the production of rice. Loamy and even sandy soils produce good crops of rice under ideal conditions of irrigation and drainage.

AREA WHERE RICE IS GROWN.

The rice acreage in California in 1914 was distributed by counties as follows (fig. 2): Butte, 11,750; Colusa, 3,000; Glenn, 120; Yuba, 100; Yolo, 80; Placer, 150; Merced, 150; Kings, 80; Kern, 100.

The production of rice in 1914 was confined to the Sacramento and San Joaquin valleys, the northern and southern sections of a continuous valley of more than 400 miles in length and from 10 to 60 miles in width that occupies the north-central portion of the State. To the east of this great valley are the foothills and the forested slopes of the Sierra Nevada Mountains. Many perennial streams flow into the valley from this region of heavy precipitation. The western wall of this valley is formed by the Coast Range. No perennial streams having their source in these mountains reach the floor of the valley.



FIG. 2.—Outline map of California, showing by circles the location and acreage planted to rice in 1914.

CLIMATE.

The prevailing climatic conditions of this great central valley are moderate rainfall, hot summers, mild winters, low humidity, and light wind movement. The region is semiarid. It seldom rains during the summer months, the rains occurring usually from October to May. These limits, however, are subject to considerable variation. The average annual rainfall ranges from 24 inches at Red Bluff to 5 inches at Bakersfield.

The mean annual temperature ranges from 60° to 65° F. The highest temperatures occur in the months of July and August, ranging from 105° to 115° F. During the hot months there is often a daily variation of 40°, resulting in rather cool nights. In the winter minimum temperatures of less than 25° F. are seldom recorded. The usual minimum is about 28° F. Frosts frequently occur in December and January.

In the Sacramento Valley the prevailing wind during the spring and autumn months is often brisk. Hot, dry winds from the north sometimes occur during the hot summer months. In their extreme form they are known as "northerners." When they continue for several days they often do considerable damage to rice, especially if they occur while the crop is in flower.

SOILS.

The larger part of the rice crop in California is on black adobe soil. This soil contains approximately 50 per cent of clay. In structure it is very close and compact. It is exceedingly tenacious and puttylike when wet. During the dry season it breaks at the surface into blocks separated by deep cracks. After long exposure to the air these blocks divide and subdivide by smaller cracks until the surface of the soil may become a loose, shallow mass of small pieces the size of peas. The subsoil, which lies at a depth of approximately 3 feet, is gray in color and is rather impervious to water. There are approximately 200,000 acres of this soil in the Sacramento Valley that may be used for the culture of rice.

The Sacramento silt loam, a light-brown soil which occupies a large area in the eastern part of Colusa County, seems well adapted to rice. It is of alluvial origin and varies in depth from 18 inches to 6 feet. In texture and structure it is variable, but, as a rule, it can be easily cultivated. The heavier type of this soil has a tendency to form hard clods, which are somewhat difficult to reduce.

Average yields of rice have been obtained on the Willows clay. This is an indefinite type of soil that occurs in large areas on the nearly level plains south and southeast of Willows. It has a depth of approximately 6 feet. This soil is of a reddish and yellowish brown clay that is compact, tenacious, and impervious. It puddles badly when wet and bakes upon exposure to the sun. On account of its texture this soil is not easy to cultivate. It contains from 0.04 to 1.2 per cent of alkali.

Rice has been successfully grown on the Alamo clay-loam adobe. This soil varies in color from dark gray to black and in depth from 1 to 5 feet. It is both sedimentary and alluvial in formation and lies upon a red hardpan. It occupies an area that is subject to overflow during the rainy season,

Other types of clay soils in these two valleys have been used for rice with success. Average yields have been obtained on some where the surface of the soil gave indications of a high alkali content. These salts may be present in a relatively small quantity near the immediate surface, and can therefore be easily removed by the irrigation water, which may indicate that with thorough drainage and an ample supply of water for irrigation rice may be profitably used to reclaim these alkali lands. Rice is apparently more resistant to alkali salts than other cereals.

Table I shows the yields and acreage of commercial rice in California in 1913 and 1914.

Late seeding and watering and barnyard grass are mainly responsible for the failures and low yields.

TABLE I.—*Yields and acreage of commercial rice in California in 1913 and 1914.*

Yield per acre.	1913		1914	
	Acres.	Per cent of total acreage.	Acres.	Per cent of total acreage.
5,500 to 7,000 pounds.....	80	1.3	600	3.8
5,000 to 5,500 pounds.....	720	11.7	2,250	14.1
4,500 to 4,000 pounds.....	2,300	37.0	3,525	22.0
4,000 to 3,500 pounds.....	1,250	20.2	4,375	27.3
3,500 to 2,500 pounds.....	800	12.9	2,750	17.2
2,500 to 1,500 pounds.....			750	4.7
Harvested, but not thrashed.....	250	4.0		
Not harvested.....	800	12.9	1,750	10.9
Total.....	6,200	100	16,000	100

PREPARATION OF THE SEED BED.

When not contrary to good farm management, and when the nature of the soil will permit, plowing should be done in the late autumn. There should be good drainage, so that the winter rains may wash out the alkali which may have accumulated in the surface soil. Deep plowing should be practiced. The action of the water during this period will have the effect of reducing the clods, which will lessen the amount of disking and harrowing necessary for preparing a good seed bed the following spring.

If plowing is postponed until spring, the land should not be left in furrows, but should be disked and harrowed at once and not allowed to dry out before sowing. The vigorous growth of the young plants, as well as high germination, is dependent upon how well the soil has been prepared for seeding.

PREPARATION OF THE SEED.

The seed should not be sown until it has been carefully fanned and screened. The fanning mill is usually used for this work. It grades the seed and removes the light grains, trash, and most of the weed

seeds. A poor stand and reduced yields are generally obtained when ungraded seed is sown. The use of cleaned seed is one method by which weeds may be controlled in a rice field.

Unless the crop is properly shocked, the germinating power of the seed may be greatly injured during a wet harvest. A germination test should always be made of seed that has been exposed to unfavorable conditions. At least three lots of 100 grains each should be taken for this test from a composite sample of the seed to be sown. Each lot should be placed separately between blotters or Canton flannel, which must be kept moist and at a temperature of approximately 70° F. Within a week each lot should be examined and the number of seeds with strong sprouts counted.

It is more economical not to sow seed of low vitality, but, if used, the rate of seeding per acre should be higher than that commonly recommended for the variety.

MANNER OF SEEDING.

In sowing rice, the seed should be distributed evenly and covered uniformly. These results are more easily obtained by drilling the seed than by broadcasting it. When drilled, less seed is required and, as a rule, a more uniform stand is secured. Any one of the ordinary forms of drill may be used if the seed bed is in good tilth.

DEPTH OF SEEDING.

Rice should be sown under ordinary conditions at a depth not exceeding 2 inches, but a greater depth may be required on a cloddy field, in order to cover the seed well. With proper moisture conditions a less depth is desirable on a well-prepared seed bed. If irrigation is necessary to germinate the seed, and in most cases it will be, the seeding should not be too shallow, or the water may float and scatter the seed.

RATE OF SEEDING.

The quantity of seed that should be sown will vary with the variety of rice, the vitality of the seed, the fertility of the soil, the character of the seed bed, and the method of seeding. Under ordinary conditions on black adobe soil 90 pounds of seed to the acre are sufficient for the Wataribune variety. The long-grain varieties, which usually do not tiller as freely as the short-grain ones (of which Wataribune is a type), should be sown in excess of the rate recommended for the latter.

Thin seeding may induce excessive tillering, which will invariably result in irregular ripening and low yields. On a good seed bed less seed will be required than will be necessary to secure an average stand on a poorly prepared one. If weedy land is used, the rate of seeding should be greatly increased. It is always necessary to use more seed in broadcasting than in drilling.

TIME OF SEEDING.

In California it requires approximately six months to mature a crop of Wataribune rice. Until other varieties can be obtained that will mature in less time, early planting should be practiced. The crop should be planted so that it may be harvested before the autumnal rains begin. If planted at an early date, the crop will flower under normal conditions during the period of high temperatures, with a resulting increase in yield and improvement in quality. The risk of losses from wet weather increases as the harvest period becomes later. In a date-of-seeding test at the Biggs Rice Field Station, in which rice was sown every 15 days from April 1 to May 15, inclusive, the early seeding invariably gave the largest yields. The yields decreased from 400 to 500 pounds per acre with each successive later planting. The same proportional decrease was noted on the commercial plantings in the vicinity of Biggs. April 1 is recommended as the approximate date for sowing rice in California. It is never safe to seed Wataribune rice after May 1.

IRRIGATION.

The water that is used for the irrigation of rice in the Sacramento Valley is obtained by gravity, mainly from the Sacramento and Feather Rivers. In the San Joaquin Valley the water is supplied by small streams and deep and flowing wells.

Because continuous submergence at a uniform depth is necessary for the growth of rice, only level land with a good slope for drainage should be selected for this crop. The field should be inclosed by strong embankments and so subdivided that each subfield shall have a surface level enough to hold the irrigation water at the required depth.

These conditions can be obtained by constructing field levees on contour lines at distances which, during submergence, will hold water at an average depth of 5 or 6 inches. These levees should be just high enough to prevent the water from overflowing into the subfields below and so broad that all kinds of machinery used in the cultivation of rice may pass over them easily without damaging them. Such levees will be low and very broad. They should be planted to rice. If this is done the cultivated area is increased and no uncultivated strips of land are left in the field for the growth of weeds. The growth of rice upon the field levees may not be equal in every respect to the main crop, but the results that will be obtained in the control of weeds alone will justify the practice.

The levees should be permanent and accurately located. For this work a competent civil engineer should be employed. The location of contour lines, the construction of levees, and the leveling should

cost about \$9 per acre for permanent wide levees and approximately \$2.60 for temporary levees.

The successful growth of this crop often depends upon the availability of water at the time of planting. While it may not always be necessary to apply water for the germination of the seed, it is never safe in this section to seed the crop without having a good supply of available water.

If the water supply is to be developed from wells, the digging of the wells should precede the planting. Where this has not been done, heavy losses have resulted. The acreage to be watered from a well should never overtax the supply. Until more is known about the underground waters of these two valleys, wells should not be depended upon as the only source of water for rice, except in the artesian districts.

On typical adobe soil, and probably on all of the clay soils upon which rice may be grown, it may be necessary to apply water to germinate the seed. A seed bed on these soils loses its moisture very quickly. Under normal weather conditions a good seed bed on soil of lighter texture may not require the application of water for germination. Such soils, if well drained, would probably permit very early planting, which, in California, will always be an advantage.

Great care should be taken in irrigating to obtain germination. Soil and atmospheric temperatures are usually low at this season of the year, and if the water is left on the land too long the seed is likely to rot. Before the plants come up, water should not be allowed to remain on the land longer than 24 to 48 hours after each irrigation. After planting, the soil should never be allowed to dry out. This will require frequent irrigation, and a supply of water should always be available and abundant enough to meet general requirements.

Tests at the Biggs Rice Field Station indicate that the land should be submerged for approximately 30 days after the plants have come up and that the best depth of water is from 5 to 6 inches. This depth should be maintained until the heads (botanically called panicles) are well turned down, when the fields should be rapidly drained.

Paying crops of rice can not be produced without submerging the land continuously for a period of several months. The growing of rice on soil that is merely kept moist and not submerged should not be considered seriously.

The amount of water required to make a good crop of rice will depend largely upon how well the outside levees have been constructed and what quantity of water is allowed to flow through the field. Poorly constructed outside levees are responsible for the loss of much water by seepage. The loss is further increased by allowing too

much water to flow through the fields in an effort to keep the field water fresh.

The levees that inclose the field should be firm and compact. If they are next to a field that is not under irrigation, they should be very broad. Seepage is greater through levees that are constructed of black adobe soil than through levees that are made of other types of clay.

After a field has been submerged, no more water should be admitted than is needed to maintain the required depth. This will be rather small if there is no loss through seepage. The overflow of water should be no more than a mere film. From many fields it is often several inches. This is an extravagant use of water and should not be practiced. The field water will not become stagnant if freshened only once in 10 days.

Too much attention can not be given to levees and to the delivery and discharge of water. Payment for water should be based upon the volume delivered. Upon this basis it would be more economically used, other conditions being equal, than could reasonably be expected when sold on a flat charge per acre.

On commercial fields of rice where the water was accurately measured during the last season in cooperation with the office of irrigation investigations of this department, the amount used on adobe soil in the vicinity of Biggs varied from 4.65 to 8 acre-feet. This range is too great, but more data must be obtained before definite statements can be made regarding the quantity of water that may be necessary to produce a crop of rice under California conditions.

One 40-acre field which produced a yield of 6,000 pounds of grain per acre received 4.65 acre-feet of water. This field had well-constructed levees and was carefully watered. The other fields did not have the levees so well constructed and were not so carefully watered. It is safe to conclude that faulty levees cause the loss of much water and that a waste of water can be prevented by giving daily attention to the manner of its application.

DRAINAGE.

A field of ripe rice should be rapidly drained. This is very necessary in order to harvest the crop at the least expense of time and labor and to prevent the loss of grain. Even with increased power a self-binder can not do efficient work on wet ground. Boggy fields will delay harvesting, and this delay will invariably result in reduced yields from the shattering of the grain.

It is just as important to provide means for the removal of irrigation water from a field of ripe rice as it is to provide means for supplying water to the growing crop. This is not appreciated as it

should be. There are difficulties, it is true, but these can be overcome. It is an engineering problem, requiring community cooperation, and can be readily solved by the creation of drainage districts.

The natural drainage facilities of the level land upon which rice is grown are always overtaxed. It is often the case that little or no field drainage can be had until outlets have been made, and the success of these depends upon their connections with watercourses of sufficient capacity. Poor drainage, or the lack of drainage, results in underproduction through the waterlogging of the land and the accumulation in the surface soil of harmful salts, commonly called alkali.

After their construction, drainage ditches need constant attention. They must be kept free from all kinds of obstructions, especially weeds, which grow luxuriantly in them, or their efficiency will soon become greatly impaired.

It should be remembered that a well-aerated soil is just as essential for rice as for any other crop, if maximum yields are to be maintained.

HARVESTING THE CROP.

Rice should be cut promptly when ripe. If exposed too long to the sun the ripe grains are likely to become cracked. Cracked grain will break when milled, and as the price of rough rice is based largely upon a crude test to determine the percentage of head rice, or whole grains, it is important that great care should be taken in cutting, shocking, and thrashing, in order to reduce breakage. In the cleaned rice market the highest price is always paid for head rice, and as a result the miller makes his highest bid on the rough rice which, in his opinion, will produce large yields of this grade.

A twine binder should be used in cutting the crop, which is ready to harvest when the kernels on the lower part of the head are not entirely hardened. At this stage of maturity the heads are well turned down. If cut earlier, a large percentage of the kernels will be imperfectly formed. If cut later, the loss from shattering is likely to be heavy, for rice shatters badly when left standing until fully ripe.

The milling quality of rice is further increased by prompt and careful shocking. As soon as the grain is cut the sheaves should be put in round shocks. These shocks should be strongly built to withstand the wind and well capped to protect the grain from rain and sun.

In building a shock (fig. 3) the first two bundles should have the butts firmly set into the stubble and sufficiently apart to be well braced when the heads are brought together. About these set up from 8 to 10 bundles in such a manner as to form a round shock, making provision at the same time for free circulation of the air. Select a large bundle to serve as a cap. Slip its band down to the heads and put it in an upright position with the heads down and in contact with the heads of the bundles forming the shock. When it is in this posi-

tion open the bundle from the center by bending the straw at the band. Pull down the straw and spread it evenly to make a covering for the heads of the cap bundle and the underlying bundles. The grain is not exposed in such a shock and is well protected from rain and sun.

The size of the shock will depend upon the degree of ripeness and the length of the straw. Small shocks should be used when the straw



FIG. 3.—A field of harvested rice in the Sacramento Valley.

is short or not entirely ripe. During dry weather the process of curing requires at least two weeks. When the crop is weedy and the weather rainy this period is considerably prolonged.

THRASHING.

Rice should not be thrashed until the kernel is hard and the straw thoroughly dry. It will dry much better in a well-constructed shock,



FIG. 4.—Thrashing rice in the Sacramento Valley.

even though exposed to heavy rains, than it will after it is stored. Good thrashing can not be done when the straw is tough, and if the grain is stored while damp it is likely to heat and mold. Moldy rice never commands a good price.

As a protection against the introduction of weeds from a neighboring farm and against the mixing of varieties, the thrashing machine

(fig. 4) should be thoroughly cleaned before using. The hulling and cracking of the grains can be prevented by a careful adjustment of the concaves.

COST OF RICE PRODUCTION.

The cost of production per acre given in Table II is computed on a yield of 3,500 pounds of grain per acre, which will increase or decrease in proportion to the yield at the rate of approximately 40 cents per 100 pounds. Although the land will be checked, the cost of production in the second year will probably be as great as in the first year because of the increased cost of plowing, preparation of the seed bed, and weeding. These figures apply to the adobe soil near Biggs, which is expensive to work. On soil of lighter texture the cost may be less.

TABLE II.—*Estimated cost of growing an acre of rice on adobe soil in the Sacramento Valley, Cal.*

Operation.	Cost per acre.	Operation.	Cost per acre.
Plowing.....	\$3.00	Shocking.....	\$1.00
Preparation of seed bed.....	1.25	Thrashing.....	7.00
Checking.....	2.60	Sacks and sewing twine.....	3.50
Drilling.....	.75	Hauling grain to warehouse.....	1.75
Boxes.....	.50	Water tax.....	5.00
Seed rice.....	2.00	Keeping field free from water grass.....	1.25
Care of crop, April to September, inclusive.....	4.00	Total.....	36.25
Twine.....	.40		
Harvesting.....	2.25		

VARIETIES.

Table III contains the names of the principal rices of the United States. The Honduras variety is extensively grown in Louisiana, Texas, and Arkansas. The Carolina Gold and Carolina White varieties are cultivated exclusively in the South Atlantic States. These three are long-grain rices and are highly valued by our domestic trade. In California they have been grown only experimentally and may never become a part of the crop, on account of their late maturity and comparatively small yields.

TABLE III.—*Period of growth and yield of the principal varieties of rice tested in the Sacramento Valley on black adobe soil.*

Name.	Date planted.		Date land was submerged.		Date of maturity.		Days to maturity.		Height of plant, including head.		Yield per acre. ¹	
	1913	1914	1913	1914	1913	1914	1913	1914	1913	1914	1913	1914
Wataribune.....	Apr. 15	Apr. 6	June 5	June 6	Oct. 6	Oct. 25	174	202	In. 41	In. 33	Lbs. 5,350	Lbs. 7,020
Omachi.....	do.	do.	do.	do.	Oct. 10	Oct. 26	173	203	38	37	5,250	6,730
Shinriki.....	do.	do.	do.	do.	do.	Nov. 1	178	209	34	30	5,420	6,730
Honduras.....	do.	Apr. 5	do.	do.	Oct. 21	Nov. 5	189	214	48	49	3,240	2,930
Carolina White.....	do.	do.	do.	do.	Oct. 20	Nov. 3	188	212	48	48	3,600	3,850
Carolina Gold.....	do.	do.	do.	do.	Oct. 19	do.	187	212	49	47	4,300	3,100

¹ Estimated upon the actual yields from one-tenth-acre plats.

The greater part of the acreage of rice in California has been planted to the Wataribune variety (fig. 5), a short-grain rice. It is late in maturing, but produces profitable yields of rough and head rice, which makes it very popular with both the rancher and the miller. It will probably continue to be the leading commercial variety until earlier high-yielding rices are obtained.

The acreage of the Shinriki variety is not likely to be increased, because of its short straw, small grain, and long period of growth, although it produces yields approximately as large as those of the Wataribune. Another short-grain rice, known as Spagnuolo, has



FIG. 5.—A commercial sample of seed rice of the Wataribune variety, which has been well thrashed and fanned. (Natural size.)

been grown on several ranches in the Sacramento Valley. It matures from three to four weeks earlier than the Wataribune and Shinriki, but shatters very badly and requires prompt harvesting. The Omachi variety has a grain very similar to the Wataribune, though slightly larger, and it may become as popular as the latter when grown commercially.

Earlier maturing varieties of good quality that will produce high yields are needed to prevent losses from high humidity and rain, which increase as the harvest period is delayed. Rices that ripen during September would not be exposed to rain at maturity under normal weather conditions and consequently could be harvested more cheaply and with less loss than could be done after the rainy season begins. Among the rices which are being tested at the Biggs

Rice Field Station are several which mature in September and are very promising in quality and yield. These are being increased for distribution.

IMPROVEMENT OF THE CROP.

Stand and yield can be greatly improved by using large, well developed seed. Such seed can be mechanically selected by using a fanning mill or some other method for cleaning and grading.

The adaptability of a variety of rice to the region in which it is to be grown should always be carefully considered. Quality and productiveness can not be obtained from a variety when it is grown under conditions that are not favorable to its best development. A large sowing of a new variety should never be made until these characters are determined. It should first be tested in comparison with the leading local variety by making small plantings of it. If it is earlier than the variety that is usually planted and is equal or better in quality and yield, it may be sown for the general crop. Home-grown seed, however, if carefully selected and well graded generally yields better than seed of the same variety from a distant locality.

In the Sacramento Valley earliness is desirable, in order to get the maximum benefit of the high temperatures at the time of flowering and to escape the autumnal rains. It can be developed by continued selection. The selections should be made at the time of ripening and from plants that are growing under ordinary field conditions if they are otherwise suitable. Plants growing near ditches or on or near levees should not be used.

The earliest and best heads should be selected and thrashed by themselves, preferably by hand. The seed obtained from them should be sown apart from the main crop on what may be termed a seed plat, the bed of which should be well prepared. When harvested the crop from the seed plat should be thrashed by itself and the seed used the next year for planting the main crop. Before harvesting the seed plat, the best heads on it should be selected for use in planting the seed plat the following year. Permanent improvement of the rice crop can be obtained by continuing this practice year after year.

If the seed plat is not used, it may pay to get seed from the best parts of the field. These parts should be cut and thrashed separately from the main crop. The seed obtained in this way will not be superior seed, but may excel in quality the seed rice which is ordinarily sold, in that it is better adapted and probably freer from weeds and red rice. By repeating this year by year the rice grown on any farm will be appreciably improved.

A better method for improving the quality and yield of the rice crop would be to test and select strains which have been developed

from individual heads, but this work should be done by the agricultural experiment stations, as it requires more attention than the average farmer can give to it.

RICE PRODUCTS.

Rice leaves the thrasher with the hull or husk attached. It is called rough rice and in this condition is sold to the miller. In the mills it is prepared for the market. After the removal of the hull and cuticle the kernels are polished. This process improves the commercial value of the rice but decreases its food value.

After the rough rice has been cleaned, to remove all kinds of trash, it is conveyed to the milling stones, between which the hulls are removed. From these stones it passes over horizontal screens where the hulls and the whole and broken kernels are mechanically separated. The unbroken kernels are now conveyed to a set of machines known as hullers, in which the outer skin, or cuticle, and much of the gluten layer of the grain, together with the germ, are removed by friction. After leaving the hullers the rice is screened and fanned, to free it from the bran. It is now ready to be polished, a process which gives the grains the pearly luster that is demanded by the general trade. In the polishing process more of the gluten layer and many layers of starch cells are rubbed off. This product is called rice polish, or flour. From the polishing machine the rice passes to screens, where it is separated into different grades.

The unbroken kernels of milled or cleaned rice are known as head rice. This kind of rice always commands the highest price and is sold under several grades, which vary in the different markets but are separated largely upon the brilliancy of the polish and the color and size of the kernels. The broken kernels may be sold as ordinary or broken rice, screenings, or brewers' rice. The last grade is composed of very fine particles of the kernels.

The principal feeds that are obtained from rice are bran, meal, and polish. The bran is composed of the cuticle and the embryo with varying quantities of hulls. Bran that contains no hulls, or comparatively none, is called meal. It is the most nutritious of the rice feeds and when fresh is very palatable to domestic animals. On account of its high percentage of fat it often becomes rancid if kept too long. In polish, or rice flour, the percentage of fat and protein is much lower than in meal, while the percentage of starch is much higher. Polish is used for feeding cattle and pigs.

WEEDS.

Under the general term of weed may be included those plants that affect the full development and marketing of any crop. The plants that normally inhabit wet places find ideal conditions in a rice field

for rapid and luxuriant growth and if not eradicated when they first appear may cause heavy losses. As a rule, weeds produce a large number of seeds. On account of this and their general hardiness they are not easily controlled. Their presence in a field adds to the cost of production, reduces the yield, and produces an inferior grade of grain. A lower price is always offered for rice containing weed seeds.

The eradication of weeds is expensive, and it is therefore important to use every method to prevent their introduction. Most weeds are probably introduced into fields by sowing seed rice that has not been thoroughly cleaned. The irrigation water furnishes another source of infestation, being supplied from the weed growth in ditches and on ditch and canal levees. The community thrashing outfit also acts as a weed distributor. The danger from these sources can be greatly minimized by the exercise of care, cleanliness, and good judgment. Weeding by hand should be resorted to as soon as weeds appear in a field, unless their number is so great that the cost would make it prohibitive. In the latter case the land should be devoted to clean culture and occasionally irrigated to germinate the weed seed. No weed should be allowed to mature its seed. This applies to weeds on roads and levees as well as to weeds in the field. The former can be handled easily and cheaply by the use of mowing machines and scythes. The planting of field levees to rice will reduce the area for weed growth.

BARNYARD GRASS.

Barnyard grass (*Echinochloa crus-galli* (Linn.) Beauv.), which is locally known as water grass, is the worst weed to be found in the rice fields of California. It is a coarse, erect, or spreading annual, varying in height from 12 to 48 inches. It is widely distributed in all cultivated regions and grows luxuriantly in fields that are continuously irrigated. This weed produces a large number of seeds. On a single plant there may be as many as 40,000 seeds (fig. 6). It is therefore not safe to allow a single plant to go to seed in a rice field, for with such reproductive powers it would soon populate the field. During the past three years this grass has taken complete possession of more than 2,000 acres of rice land in the Sacramento Valley and is now present in alarming quantities on a considerable acreage, which will soon be rendered unprofitable for rice growing unless active steps are taken for its complete eradication or control.

This weed has probably been more widely distributed through the use of seed rice containing its seed than by any other means. Water from irrigation ditches upon whose banks it has been allowed to grow contributes its quota of seed. Occasionally the seed of this grass is carried from one field to another by the floods which sometimes occur during the winter.

Seed rice containing the seed of barnyard grass should not be used (fig. 7). As soon as this grass appears in a field it should be removed by hand before it goes to seed. Its seed usually germinates with the rice and in about two weeks after coming up it develops a more vigorous growth and a lighter green color than the rice plants. In 65 days after coming up it produces ripe seed, which, if allowed to germinate, will develop plants that will mature before the rice crop is harvested. None of these plants should be allowed to seed.

The only satisfactory method known at present for the eradication of this weed is to remove it from the field by hand work. On account of their large root systems it is not practicable to pull up the plants.

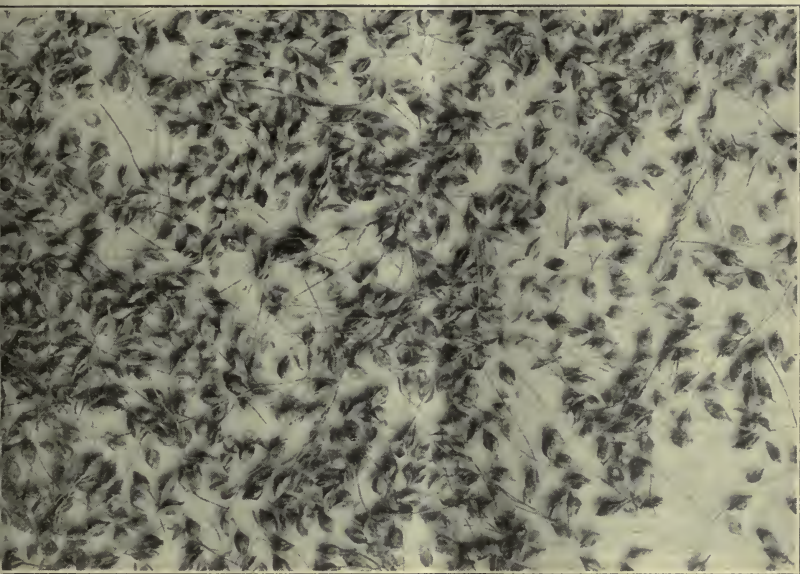


FIG. 6.—Seeds of barnyard grass. (Natural size.)

They should never be cut off at the surface of the ground, as is often done, for a new growth will develop and produce seed in about 40 days. The plants should be cut below the crown, which is usually covered with 2 inches of soil. Plants which have been cut at the surface have been known to develop seed as many as four or five times during a season. As soon as they have been cut the plants should be removed from the field, for they will continue to grow if they are allowed to remain in moist or wet places.

It has been found practicable and advisable to cut this grass from fields even when the growth is very heavy. The cost of eradication will depend largely upon the quantity in the field and upon the class and cost of the labor employed. The actual expense of cutting ranges from \$2 to \$5 and even more per acre. Several farmers have spent

with profit as much as \$10 per acre to remove this grass from their fields. If this weed is allowed to seed in any quantity during the first year, it becomes very difficult and almost impossible to eradicate it during the second year.

A rotation of crops, including a cultivated one, and summer fallowing may be employed as the best means to obtain complete eradication of this weed. Conditions should first be made favorable for the germination of the seeds that are in the soil. After germination the plants should not be allowed to produce seed. This can be effectively done by frequent cultivation or by plowing the land as the



FIG. 7.—A commercial sample of seed rice of the Wataribune variety, containing many hulled grains and the seeds of barnyard grass. (Natural size.)

seed germinates. Irrigation will probably be necessary to assure germination.

In three seasons this weed has become a menace to the rice crop of the Sacramento Valley, and unless concerted action is taken for its control or eradication its presence may seriously affect the normal development of the rice industry of the State. This work may be effectively done through county or community organizations with police power.

RED RICE.

The worst weed of the rice fields of the United States is red rice. It has been introduced into California through the purchase of seed rice from the Southern States. Since imported seed may contain as much red rice as domestic seed there is also danger from this source.

This weed is well distributed throughout the rice-producing countries of the world. The seed coat of the kernel of this rice is red, a characteristic which may serve to distinguish it from the white rices. Wherever it is introduced, and this is possible only through the use of seed containing red rice, it soon takes possession of the field unless active measures are taken to eradicate it. In discussing seed rice from the standpoint of red rice only, the importance of pure seed can not be overestimated. After heading, red rice can be readily distinguished from our commercial varieties by its loose, open, lightly drooping head with comparatively few grains on the branches. A slight infestation of a small acreage may be easily controlled during the first year by pulling up the individual plants and removing them from the field. If this is not done, the quantity of red rice the second year will be greatly increased, for the seed of this rice shatters very readily. Of course some of it will be harvested and thrashed with the main crop, but the quantity will be proportionately small, though large enough to affect the grade. The presence of red rice always lowers the value of the crop.

WILD OATS.

The wild oat (*Avena fatua* L.) is not to be considered a serious weed in the rice field, though it often makes a vigorous growth in fields where the stand is thin. It is usually brought under control when the first continuous irrigation water is applied.

CANARY GRASS.

Canary grass (*Phalaris paradoxa* L.), which thrives in wet soil, has caused loss in some fields. It germinates with the rice and, as it grows much faster, it may seriously affect the early growth of the crop if it is very abundant. While canary grass may never become a troublesome weed, it should not be allowed to establish itself in a rice field. It should be removed by hand when it first appears.

SUMMARY.

Clay soil with an impervious subsoil, if it lies in level tracts and can be well drained, is well adapted to rice.

Shallow soils are preferable to deep soils, because less water will be required to submerge them.

Rice requires an abundant and always available supply of water.

April 1 is recommended as the approximate date for sowing rice in California. It is never safe to sow seed of the Wataribune, which is the leading commercial variety, after May 1.

On typical adobe, and probably on all of the clay soils on which rice may be grown, it may be necessary to apply water to germinate the seed. Great care should be taken in irrigating to obtain germina-

tion. Before the plants emerge, water should not be allowed to remain on the land longer than 24 to 48 hours after each irrigation. After planting, the soil should never be allowed to dry out. The water should be applied not less than 4 inches deep, and preferably from 5 to 6 inches, and should be applied approximately 30 days after emergence.

The field should be rapidly drained when the heads are well turned down.

The growing of rice on soil that is simply kept moist and not submerged is not to be seriously considered.

More data must be obtained before definite statements can be made regarding the quantity of water that may be necessary to produce a crop of rice under California conditions.

Field and outside levees should be permanent and accurately located.

Poor drainage, or the lack of drainage, results in underproduction through the waterlogging of the land and the accumulation in the surface soil of harmful salts, commonly called alkali.

Rice should be cut promptly when ripe. If exposed too long to the sun the ripe grains are likely to become cracked, which will cause heavy breakage in milling.

Early-maturing varieties of good quality that will produce high yields are needed to protect the crop from the probable losses through high humidity and rain, which increase as the harvest period is delayed.

Barnyard grass is the worst weed to be found in the rice fields of California. It has taken possession of more than 2,000 acres of rice land in the Sacramento Valley and is now present in alarming quantities on a considerable acreage, which will soon be rendered unprofitable for rice growing unless active steps are taken for its complete eradication or control. Seed rice containing the seed of barnyard grass should not be used. When present in a field in small quantity it should be removed by hand. A rotation of crops, including a cultivated one, and summer fallowing may be employed as the best means of obtaining the complete eradication of this weed.

I 1d.

U. S. DEPARTMENT OF
AGRICULTURE
FARMERS' BULLETIN No. 690

THE FIELD PEA
AS A
FORAGE CROP



THE FIELD PEA is widely grown in Canada, and is important in the United States in the northern tier of States and in regions of high altitude farther south in the Rocky Mountains.

The field pea deserves wider use as a winter legume in the Southern States.

Cool weather during the growing season is essential.

The best yields are made on clay-loam soils.

The best early field pea is the French June, the best midseason variety the Golden Vine, and among the most popular late varieties are the Canadian Beauty and the Blue Prussian. Of the newer varieties the Carleton, Kaiser, Bangalia, Paragon, and Gregory are valuable and should be grown more widely.

The field pea should not be cut for hay until the pods are well formed, and for grain it is not well to harvest until the earliest pods are turning yellow.

Pasturing field peas with sheep or hogs has been found profitable in the San Luis Valley of Colorado and is worthy of trial in other pea-growing districts, especially those located near range lands.

When grown for hay, mixtures of field peas with oats or barley are recommended.

Field-pea seed has been used with success as a concentrate in feeding rations for the production of both meat and milk.

Because of its effect on the fertility of the soil, the field pea is valuable in crop rotations, and its use as a substitute for summer fallow in the wheat-growing districts of the Northwest is advised.

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THE FIELD PEA AS A FORAGE CROP.

H. N. VINALL, *Agronomist, Office of Forage Crops, Bureau of Plant Industry.*

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DESCRIPTION OF THE FIELD PEA.

THE FIELD PEA is an annual plant with slender stems 2 to 4 feet high, which stand erect only where there are other objects to which they can cling. The plants seldom have more than three stalks and very often only one or two. The herbage is pale green with a whitish bloom on the surface. Each leaf bears usually two or three pairs of leaflets and is terminated by a slender, branched tendril. (Fig. 1.) The flowers are reddish purple, pink, or white, mostly two or three to each flower stalk. The hanging pods are about 3 inches long, each containing five to nine nearly round seeds. The garden pea is cultivated primarily as a green vegetable or as a grain crop for human food; the field pea is grown for hay or for grain feed to animals. In many cases, however, the same variety is grown for both purposes.

Generally speaking, the varieties with wrinkled yellowish or greenish seeds and white flowers are classed as garden peas, while those with smooth seeds are considered field peas. Some field-pea varieties have yellow seeds and white flowers, while others have colored blossoms and brown, marbled, mottled, or speckled seeds.

Some confusion of name has arisen in this country because in the South the cowpea is often called the field pea, while in the same region the garden pea is distinguished as the English pea. The cowpea is really a bean, resembling the common bean both in its leaves with three large leaflets and no tendrils and in its kidney-shaped seeds. Further, on account of the fact that the true field pea is more largely grown in Canada than in the United States, it is frequently called the "Canada field pea" or the "Canadian field pea."



FIG. 1.—Fruiting branch of a field-pea vine, showing the characteristics of stem and leaf and the succession of bloom and pods.

This bulletin treats of the field pea as a forage crop, whether grown for hay or for grain for stock, and does not include the cowpea, which, as already stated, is really a bean.

HISTORY.

The native home of the pea is supposed to be in that part of western Asia extending from the Mediterranean Sea eastward through Syria and Palestine to the Himalaya Mountains. It appears to have been one of the first cultivated crops, as seeds have been found among the relics of the Stone Age in Switzerland. It was, perhaps, one of the first crops to be brought over by the colonists to the United States, since there are records of its

being grown in Virginia as early as 1636. The cultivation of the field pea did not spread rapidly in that section of the United States, but as the country developed it gained more and more favor in Canada and became a staple crop in the United States only in the New England States, New York, Michigan, Wisconsin, Minnesota, and the eastern Dakotas.

The total area devoted to the field pea in the United States, although considerable, has never been reported in the census; hence, no definite figures are available. The maximum production in central and eastern Canada, to judge from the Ontario reports, was probably reached in 1897, when 896,000 acres of field peas were reported in that Province alone. The acreage in Ontario had decreased to 258,000 in 1909, the decrease being due largely to the attacks of the pea weevil.

The cultivation of the field pea throughout western Canada has increased with the settlement of that territory. In Washington, Oregon, Idaho, and western Montana it has also been found well adapted to the climate and soil and is steadily increasing in importance as a farm crop. (Fig. 2.)

CLIMATIC AND SOIL ADAPTATIONS.

A cool growing season is essential for the field pea. High temperatures are much more injurious than frosts, which are disastrous to the crop only when they occur just at the period when the pods are setting. These climatic requirements of the field pea limit its successful production as a summer crop to the Northern States and Canada and to high altitudes in the mountains of our Western States. It may, however, be grown with profit as a winter crop in the Southern States. (Fig. 3.) Its moisture requirements are less important than those of temperature, but, other things being equal, it does best where the rainfall is fairly abundant. A 15-inch rainfall in western Canada is sufficient to produce a good crop, while 20 inches of rain in Kansas, Nebraska, or Colorado are inadequate.

Long experience with the field pea has indicated that clay loams of limestone formation are best suited to its culture. As is the case with most other legumes, the field pea thrives best in a calcareous soil. Where the soil is not of limestone formation it is advantageous to add lime frequently. The field pea also does fairly well on sandy loam



Fig. 2.—Field peas in bloom near Pullman, Wash., showing the vigor and uniformity of growth attained in that locality.

soils, but on loose, light sands the growth is usually small and the crop suffers quickly in periods of drought.



FIG. 3.—Outline map of the United States, showing areas to which the field pea is well adapted.

Heavy, black soils rich in humus tend to produce a heavy growth of vines but comparatively few pods. One may expect a large tonnage of hay on such soils and a small seed yield.

Good drainage is essential for success with the field pea. It grows well on moist soils, but will not succeed in locations where standing

water occurs or where the soil is habitually soggy. Experiments in Wyoming indicate that soils strong in alkali are disastrous to the crop.

VARIETIES.

The variety of field pea grown in any region depends primarily upon its adaptation to soil and climatic conditions and to the object for which the crop is being grown, but local prejudice and the availability of seed peas also affect the choice. The best general-purpose pea and the one most widely known is the Golden Vine. Short descriptions of the principal varieties follow. The seeds of most of them are shown in figure 4.

Golden Vine.—The Golden Vine is a medium-early variety having a white blossom and a small, round, cream-colored seed. It has become popular in the United States on account of its uniformly good yields of both forage and seed and the fact that it is usually easy to obtain. The small seeds also make the cost of seeding less.

French June.—This is one of the best early varieties. It has white blossoms and is almost identical in seed characters with the Golden Vine, but it matures nearly two weeks earlier and the vine is not so large. In spite of these differences considerable confusion exists in respect to these two varieties, and the Golden Vine is often sold as French June.

Marrowfat.—This group of varieties is known to the seed trade under the name Marrowfat, White Marrowfat, and Large White Marrowfat, besides many other more distinctive varietal names, such as Canadian Beauty, Gregory, Arthur, and Potter. The Marrowfat varieties have white blossoms, large, round, cream-colored seeds and large vines. All are rather late in maturing.

Blackeye Marrowfat.—This group of varieties has seeds very similar to those of the White Marrowfat except that they have a black hilum, or "eye." As a rule, the peas of this group mature a little earlier than those of the Marrowfat and the vine growth is less. Among the named varieties which belong to this group are the Paragon and the Mackay, two varieties which are among the best yielders in Canada.

Wisconsin Blue.—This is also a well-known variety. It has white blossoms and medium-sized, round, bluish green seed. The vines are large and it is rather late

maturing about the same time as or later than the Marrowfat. It is quite popular in the northern United States. Other rather important blue-seeded varieties are the Scotch, Blue Imperial, Prussian Blue, and Concordia. The whole group of blue-seeded field peas is grown rather extensively in the Lake region of the United States, where they are utilized both as soup peas and for stock feed.

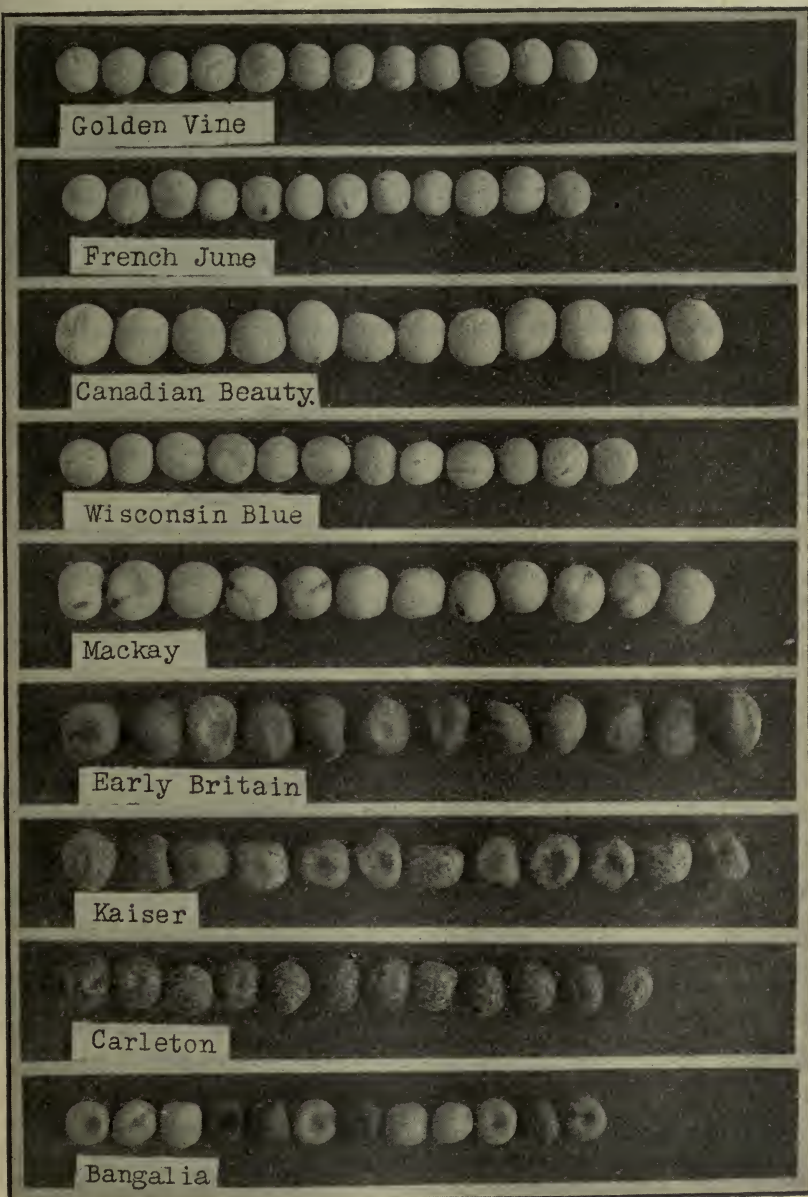


FIG. 4.—Seeds of several important varieties of field peas, showing the most common sizes, shapes, and color markings. (Natural size.)



FIG. 5.—A plat of field peas at the San Antonio (Tex.) Field Station. Photographed in the spring, when about ready to be plowed under.

Early Britain.—The Early Britain is a very distinct variety, having medium to large brown-colored seeds which are dented on the sides, giving them a somewhat wrinkled appearance. It has colored blossoms and a rather stocky vine with large leaves. The Early Britain is about three or four days earlier in maturity than the Golden Vine and is one of the leading varieties in Canada.

Gray Winter and Austrian Winter.—These two varieties are very similar. They both belong to the group of winter-hardy varieties having purple blossoms and small round seeds, gray in color, marbled with brown. These varieties will endure lower temperatures than most field peas and are valuable as winter-cover and green-manure crops on the Atlantic and Gulf Coastal Plains and the Pacific slope of Washington and Oregon.

Carleton.—This field pea, which is similar to the Gray Winter, was obtained from New Zealand and has proved to be of special importance in the dry regions of Washington and Oregon.

Bangalia.—This variety, secured from India by the United States Department of Agriculture, is fast becoming one of the leading field peas of eastern Washington, northern Idaho, and western Montana, where it has made consistently good yields both with and without irrigation. It resembles the Golden Vine in size of vine, date of maturity, and shape and size of seed. The seeds, however, are greenish in color, turning brown with age. The blossoms are colored.

Kaiser.—The Kaiser is a variety introduced from Germany by the United States Department of Agriculture. It has medium to large, deeply dented seeds, gray in color and speckled with purple. The stems also are strongly tinted with dark red. It matures with the Golden Vine or a little earlier and is a good general-purpose pea. A marked peculiarity is its ability to endure high temperatures, which should make it of special importance on the southern edge of the pea-growing district.

PREPARATION OF THE SEED BED.

Most growers claim that it is advantageous to fall plow the land for the field pea, on account of the necessity for early seeding. It is usually possible to sow a week earlier when the land has been fall

plowed than if it is plowed in the spring, and the opening up of the soil to the action of the frost during the winter also improves its texture. Spring plowing is satisfactory if it can be done early, and where the seed is to be broadcasted by hand it is easier to cover it properly on freshly turned land than on plowed land which has been allowed to settle during the winter. Where the ground is fall plowed

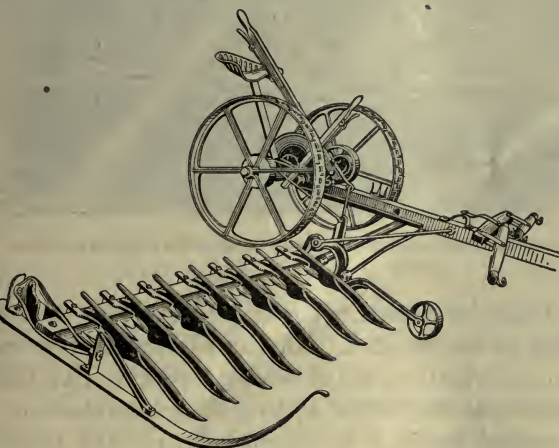


Fig. 6.—A mower, showing an attachment designed to raise the pea vines off the ground and allow the passage of the cutter bar beneath them.

it is well to work it with a disk as early as possible in the spring and smooth it down after the disk with a drag harrow in case the seed is to be planted with a drill. If one expects to sow the field peas by hand, the ground may be left slightly rough and the seed covered with a disk harrow. Finely pulverized soil is advantageous for the field

pea, but not so necessary for it as for the small grains, since the seed is much larger and the small plant correspondingly stronger.

SEEDING.

An important thing to remember is that the field pea must be planted early enough to have time to set its pods before the warm weather of summer arrives. High temperatures are of value to the pea crop only during the ripening period. The young plants are not harmed by light frosts, and even as far north as southern Canada and the northern part of Michigan, Wisconsin, and Minnesota the seed can be planted during the latter part of April and the first of May. In the intermountain sections of Colorado, Wyoming, Montana, and Idaho, from the first to the middle of April is the most favorable time. Throughout the Southern and Pacific Coast States in localities where there is little danger of a hard freeze during the winter, the field pea should be seeded in the fall or early winter. At San Antonio, Tex., the best time for seeding was found to be November 15 to 30. In intermediate latitudes, where hard freezes may be expected during the winter, farmers sometimes sow the peas in February, and in this way give them time to mature in May before injurious hot weather is likely to occur. (Fig. 5.)

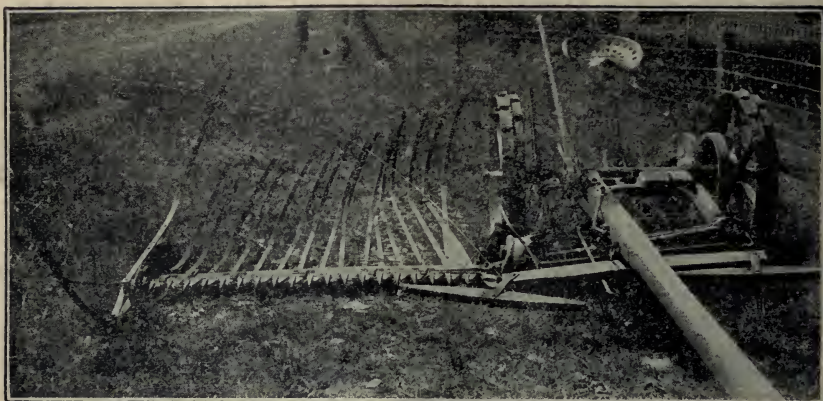


FIG. 7.—A mower with a windrow attachment which automatically removes the material from the swath.

The rate of seeding must be varied according to the size of the seed and the abundance of the rainfall. In the eastern and more humid sections and under irrigation, small-seeded varieties, like the Golden Vine, should be sown at the rate of $1\frac{1}{2}$ to 2 bushels to the acre; for those with medium-sized seeds, 2 to $2\frac{1}{2}$ bushels; for the large-seeded varieties, like the Marrowfat, 3 to $3\frac{1}{2}$ bushels of seed are required. Under more arid conditions, the quantity of seed used should be decreased by about one-half bushel for each group, and when planted in rows 50 to 75 pounds to the acre are enough. For a mixture with oats the relative proportions should be 1 bushel of peas to $1\frac{1}{2}$ or 2 bushels of oats in the humid regions, but in the dry region the relative amounts of seed should be very nearly reversed. Unless the proportion of oats in the mixture is decreased where the rainfall is light the oats, which start more quickly than the field peas, will prevent any growth of the latter by robbing them of available soil moisture. Mixtures with grain are of doubtful value in regions of light rainfall.

The field pea is best sown with a grain drill, and if either a hoe drill or a disk drill is available it should be used in preference to broadcasting the seed by hand. Peas should be planted from 2 to 4 inches deep, according to soil conditions. In clay loam a depth of 2 inches is best, while in sandy soils a deeper covering is to be preferred. Where a grain drill is not available, peas may be sown broadcast and covered with a disk or drag harrow. Some growers have followed the practice of plowing under the pea seed, but this usually covers it too deep and causes a poor or uneven germination. Care must be used to see that the feed in the drill does not crack the seed. For sowing peas, a drill in which the amount of seed delivered is controlled by the size of the opening in the feed rather than by the



FIG. 8.—Thrashing field peas with an ordinary steam thrashing outfit equipped with a self-feeder.

rapidity of its motion is essential. The distribution of the seed, the depth of covering, and the consequent germination are sure to be more uniform where a drill is used. In Ontario the results of 30 experiments throughout the Province gave an average increased yield of $1\frac{1}{2}$ bushels to the acre for drill-planted fields over those sown broadcast.

Seeding in double rows is practiced to a considerable extent in the drier portions of Washington and Oregon. This is accomplished most successfully by using an ordinary grain drill in which part of the holes or feeds have been closed. Two open holes should alternate with four closed ones, so that each pair of rows will be 30 to 35 inches distant from the next pair, thus allowing room for cultivation. This method is advised especially for new lands by some writers.

INOCULATION.

To secure the best results, field peas, like all other legumes, must have upon their roots nodules caused by nitrogen-fixing bacteria. The almost universal use of the pea as a garden vegetable has supplied the soil with the necessary bacteria in nearly all parts of the United States, so that it is seldom necessary to inoculate the soil artificially. In the newly developed farming districts of our Western States the soil may not contain the necessary bacteria, and in such cases it will be found profitable to provide inoculation. This can be done either through the use of pure cultures, a limited quantity of which can be procured from the United States Department of Agriculture free of charge,¹ or by the use of soil from fields which have previously grown a crop of inoculated peas. Inoculated soil can usually be obtained from gardens where peas have been grown. This soil should be broadcasted at the rate of 250 to 500 pounds per acre

¹ Decided increases in the yield of field peas when inoculated by this method are reported by the Office of Soil-Bacteriology and Plant-Nutrition Investigations of the United States Department of Agriculture for California and a few other States, especially in the new agricultural lands of the West.

when the ground is being prepared for seeding. Care must be used to cover the soil at once after it is scattered, so that the bacteria will not be destroyed by the sunlight. This can be done by following with a harrow immediately after the person who is broadcasting the soil.

Successful inoculation has also been attained by moistening the peas slightly when ready to begin seeding and then sprinkling over

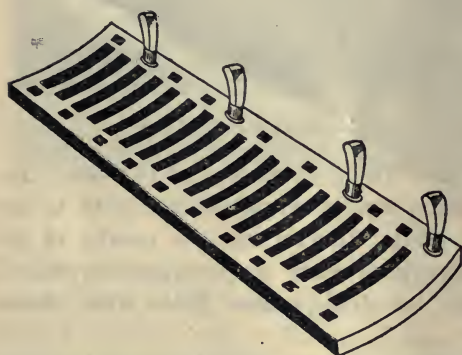


FIG. 9.—Concave plates with all but four teeth removed, adjusted for thrashing field peas.

them soil taken from a garden plat where peas have been grown successfully the year before. The seed peas should then be shoveled over thoroughly, so that each pea will have adhering to it some particles of soil. This method is less expensive than scattering inoculated soil over the field and is fairly successful if the peas are seeded soon after treatment without being exposed to the sunlight. A

variation of this method is to dip the seed peas into muddy water prepared with soil which has grown peas and is known to contain the bacteria.

HARVESTING AND THRASHING.

The proper time to cut peas for hay is when most of the pods are well formed, since considerable of the nutrient value of the plant is contained in the seed. When seeded in mixtures with grain, the time of cutting may be governed to some extent by the maturity of the grain, but the varieties of peas and grain used in the mixture should be so chosen that the crop can be harvested at the most favorable period of maturity for both. Formerly, a crop of field peas was considered very difficult to harvest, and much of the harvesting was done with a scythe or an old-fashioned cradle. This was thought necessary, first, because the vines are often tangled and, second, because of the loss from shattering where mower and rake are used. There is now available, however, an attachment for the ordinary mower which consists of guards that extend in front of the cutter bar, lifting the vines off the ground, so that the mower can pass underneath without becoming entangled in the vines themselves. (Fig. 6.) The cost of this attachment is usually from \$12 to \$15. There is also a windrow attachment which effectually removes the peas from the swath and leaves them in a windrow behind the mower. (Fig. 7.) Where such an attachment is not used it is necessary to have a man with a fork follow the mower and move the vines to one side, so that

the team and mower will not pass over the peas in the following round. A mower fitted with the above attachments works well in fields that are smooth and free from stones. The peas can be left in the windrow or bunched with a rake and left until dry and ready to stack. When stacked in the open it is necessary to protect the stacks by means of canvas covers or with a layer of green grass placed over the top.

The field pea should be cut for seed when the pods are fully mature and the peas have become firm. It is not well, however, to wait until the vine and pods are both dry, since if that is done the loss from shattering is sure to be large. Peas are most commonly cut for seed with an ordinary mower equipped with a bunching attachment, but the windrow attachment previously described may also be used with good results. When the bunching attachment is used, a man with a pitchfork follows the mower and moves the bunches out of the path of the horses on the succeeding round. This method leaves the peas in better condition to haul to the thrashing machine or stack than where they are merely windrowed, and it prevents to a large degree the shattering which would accompany any use of a hayrake. In a great many cases the field pea is thrashed directly from the bunch or windrow, as it is very difficult to construct a stack so that it will shed water. If the peas are rained on during the period while they are curing in the windrow or in bunches, they should be turned over as soon as the top of the bunch is dry. If this is not done the peas underneath will swell and burst the pods, so that when they become dry a great percentage will shell out and be left on the ground. Whenever possible, the peas which are intended for thrashing should



FIG. 10.—Treading out field peas with horses and a concrete roller. Few peas are cracked by this method of thrashing.

be stacked under a shed, but if necessary to build the rick outside, it must be protected as noted for hay.

The thrashing of the field pea is usually done with an ordinary grain separator (fig. 8) fitted up especially for the pea by the substitution of blank concaves, leaving only one row of concave teeth below the cylinder. Usually four concave teeth are sufficient to retard the passage of the vines long enough so that the cylinder will break up the pods and release the seeds. (Fig. 9.) By thus limiting the number of concave teeth and reducing the speed of the cylinder about one-half it is possible to thrash the field pea without cracking any consid-



FIG. 11.—A machine designed to facilitate the hand picking of peas and beans.

erable percentage of the seeds. In regions where the field pea is very largely grown, the thrashing machine is commonly equipped with an adjustable pulley wheel made of wood, which can be bolted to the regular cylinder pulley, thus making this pulley large enough to decrease the speed of the cylinder to the required number of revolutions. Where the peas are intended wholly for feeding purposes such precautions are not

necessary, since cracked seed is then not objectionable. Where the peas are to be sold for seed purposes, however, great care should be used in thrashing, and the peas should be run through a fanning mill after coming from the machine, in order to remove the remainder of the cracked seed. A small pea huller, of which there are several kinds on the market, is well adapted to the uses of a farmer who is growing only a small acreage and expects to sell his thrashed peas to a seed dealer. Where the returns from his pea crop do not warrant the purchase of a machine of this kind and no grain-thrashing outfit is available, the farmer can thrash seed for his own use with a flail or by treading out the peas with horses, as shown in figure 10.

After the peas are flailed or tramped out with horses, considerable work is required to separate the seed from the trash, so that this becomes in the end a rather expensive method of thrashing. A number of seedsmen make a practice of hand picking their better grades of peas, for which grades they charge an advanced price. A simple and inexpensive machine devised to carry the peas on a broad canvas belt slowly before the operator greatly facilitates this process and lessens the labor and cost of picking. The belt is moved by means of a treadle similar to that on a sewing machine. (Fig. 11.)

PASTURING FIELD PEAS.

It is a common practice in some localities to harvest the crop by pasturing with hogs or sheep. This is done more largely in the San Luis Valley of Colorado than in any other part of the United States. There is no doubt, however, that the crop can be fully as well utilized this way in other Western States in localities which are near large sheep ranges. When intended for pasture, the field pea is sown alone or with but little grain, as it is not necessary in such cases that it be supported by some more erect growing crop. Animals pasturing a field peas should be confined to one portion of the field by means of movable fences, or else a herder should be employed for this purpose. If sheep or hogs are allowed to roam about over the entire field, they waste a great deal of the crop by wandering around aimlessly as soon as their hunger has been satisfied. The animals should not be turned into the field until the seed becomes hard. Lambs will fatten on field-pea pasture in from 70 to 90 days, and a good crop will usually fatten from 10 to 15 lambs per acre, each animal gaining about 8 pounds a month. Hogs in a thrifty condition will fatten in from 60 to 90 days, and if not obliged to gather their food over too large an acreage will make an average daily gain of 1 pound.¹

In pasturing hogs or sheep on field peas it is well to remember that good results can not be hoped for unless feed is abundant. The only way to assure continued substantial gains is to move the fattening animals to a new field as soon as peas become scarce and to use stock animals for picking up the scattered peas and for "cleaning up" the field. Hogs especially will not put on flesh rapidly if they are forced to travel about considerably to gather food. Pasturing is a wasteful method of harvesting a crop, even under favorable conditions, and when the weather is bad it not only prevents the animals from feeding properly, thus causing them to lose flesh, but also adds heavily to the direct loss of the crop itself. Many farmers in the San Luis Valley of Colorado are discontinuing the practice of pasturing their field peas on account of this loss and are harvesting

¹ Faville, A. D. Swine feeding. Wyo. Agr. Exp. Sta. Bul. 107, p. 16-21. 1915.

all or a part of their crop and feeding it in a feed lot. A combination of pasture and dry feed has been found best. The animals after a period of pasturing make better gains on dry feed than where given dry feed during the entire feeding period. Alfalfa or sweet-clover pasture used in connection with field peas noticeably increases the rapidity of gain.

MIXTURES WITH SMALL GRAINS.

The field pea is often sown in mixtures with small grains, primarily to hold the vines off the ground and thus make the harvesting of the crop easy. Oats are more often used for this purpose than the other grains, although barley is used to some extent and wheat



FIG. 12.—Sheep which have been fed crushed peas and barley in connection with pea silage, near Sacacaio, Colo. Note the splendid condition of the ewes. (Photographed by E. H. Thomas.)

in a few cases. The yield is nearly always larger when oats are used than with either barley or wheat. Mixtures are recommended in all cases where the crop is to be used exclusively for hay. The presence of oats or barley in the pea hay makes a better quality of feed than pea hay alone.

Mixtures are occasionally used when the field pea is grown for grain purposes, and in this case the peas and small grain are thrashed out together and the seed separated by means of sieves, either in the thrashing machine itself or in a fanning mill afterwards. It is doubtful, however, whether the greater ease of harvesting is sufficient to overcome the additional trouble required to separate the peas and grain.

FIELD PEAS AS A GRAIN CROP.

Field-pea seed has been used quite extensively by the farmers of Ontario in feeding farm animals, and beef, mutton, and pork produced with a ration composed partly of field peas is said to have a particularly agreeable flavor.¹ Feeding experiments, however, indicate that the peas used alone as the grain part of a ration are no better than corn, bushel for bushel, in amount of grain produced and are a much more expensive feed.²

The field pea is reported also as being very efficient in a ration for milch cows, especially when the peas are mixed with oats.³ It is doubtful whether a feeder is ever justified in using field-pea seed alone, for several reasons. In the first place, when ground or crushed the meal is heavy and hard to digest, and in addition to this failing it is too high in protein and too low in fat to make its use as a concentrate economical unless it is mixed with other grain feeds strong in fat and carbohydrates. Table I, from Wyoming Agricultural Experiment Station Bulletin 84, illustrates this point.

TABLE I.—*Analysis of the food value of field peas and corn.*

Feed.	Digestible nutrients in 100 pounds.		
	Protein.	Carbo- hydrates.	Fat.
	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
Peas.....	16.8	51.8	0.7
Corn.....	7.9	66.7	4.3

The proper place for the field pea in feeding operations seems to be as a mixture with oats, barley, corn, or wheat bran, being used as a carrier of protein in the northern feeders' ration much as cottonseed meal is used in the South. (Fig. 12.)

It is always well to grind the peas before feeding, as the seeds of most varieties are very hard, and except when fed to hogs good results can not be expected unless they are ground before being given to the animal. Besides being used in the ordinary feed lot, a great many of the peas, especially in the eastern part of the United States and in southern California, are used by pigeon fanciers in the production of squabs and also by poultrymen as a constituent of their chicken feeds. A small round pea, similar to the Golden Vine, is

¹ Day, G. E. Bacon production. Ontario Agr. Col. and Exp. Farm Bul. 129, p. 15. 1903.

² Carlyle, W. L. Feeding ground corn versus ground peas to lambs before and after weaning. In Wis. Agr. Exp. Sta. 16th Ann. Rpt. [1898]/99, p. 44-61, fig. 4-5. 1899.

³ Day, G. E. Experiments in the feeding of live stock. Ontario Agr. Col. and Exp. Farm Bul. 110, p. 1900.

— Peas vs. corn for fattening steers. In Ontario Agr. Col. and Exp. Farm, 27th Ann. Rpt., 1901, p. 1902.

• Murray, James. Experiments with peas. Canada Exp. Farms Rpts., [1908]/09, p. 280-281. 1909.



FIG. 13.—A stack of pea-vine refuse from a canning factory at Geneseo, N. Y. Note the incline upon which the load of refuse is hauled to be dumped on the stack.

preferred in such cases. The color of the pea is not a matter of importance in feeding it to pigeons or chickens. In the Lake region, however, where the production of the field pea for stock purposes is combined with the canning industry, the growers prefer a green or white seeded pea, in order that the crop may be available for table use whenever canning factories will pay a higher price for the commodity than will the stockman or grain dealer.

FIELD PEAS AS A HAY CROP.

The field pea is commonly grown in Pennsylvania and New York for hay, and the larger part of the crop in the Southern States is also used in this manner. When grown for hay, the field pea is almost always sown in a mixture with oats or some other small grain. As stated before, these mixtures with grain stand up much better, causing less trouble in the harvest, and the presence of oats or barley in the crop also causes it to cure more quickly. The yield from a mixture of oats and peas is usually larger than that from timothy. The field pea works into a rotation very nicely, because of the fact that when harvested for hay it is removed from the field early in the year, thus allowing time for thorough preparation of the soil during the fall. The feeding value of pea hay is quite high, being apparently about the same as that of alfalfa hay. Table II shows the average of all American analyses of field peas and alfalfa, as compiled by Mr. G. L. Bidwell, of the Bureau of Chemistry of the United States Department of Agriculture.

TABLE II.—Comparative analyses of the dry matter in field pea and alfalfa hay.

Crop.	Ash.	Protein.	Crude fiber.	Fat.	Nitrogen-free extract.	Number of analyses.
	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	
Field pea.....	8.68	19.05	28.14	3.23	39.75	
Alfalfa.....	8.86	16.35	26.74	3.00	45.05	

Even the straw from thrashed peas carries a sufficiently high percentage of protein to warrant its careful preservation and use in the feed lot. The digestible nutrients in pea straw compared with those of other well-known roughages, as compiled in Henry's "Feeds and Feeding," are shown in Table III.

TABLE III.—*Digestible nutrients in 100 pounds of air-dry substance.*

Feed.	Protein.	Carbohydrates.	Fat.
	<i>Pounds.</i>	<i>Pounds.</i>	<i>Pounds.</i>
oat hay.....	6.8	35.8	1.7
clover hay.....	2.8	43.4	1.4
alfalfa hay.....	4.3	32.3	.8
timothy hay.....	1.2	38.6	.8
bermuda grass.....	.7	41.2	.6
corn stover.....	1.7	32.4	.7

FIELD PEAS AS SILAGE.

It is not economical to put the field pea in the silo alone, on account of its high protein content. It makes a better balanced ration and keeps better when combined with some small grain, which should be mixed with the peas in sowing if the crop is intended especially for ensilage. Excellent results from the use of field-pea ensilage are reported from the San Luis Valley of Colorado, and the number of silos in the valley increased from 2 to over 100 in four years. The field peas intended for ensilage usually are planted in mixtures with bald barley and cut when the barley is ripe. This mixture of peas and barley is run through a regular silage cutter and placed in the silo at a cost of \$1 a ton. The yields average from 8 to 12 tons to the acre. Pea ensilage has a higher feeding value than corn ensilage, but should be fed in connection with a



FIG. 14.—Field peas growing in an orange grove at Redlands, Cal. (Photographed February 9, 1909.)



FIG. 15.—Mixture of Austrian Winter field peas and rye on the Arlington Experiment Farm, near Washington, D. C., sown October 10, 1923; photographed June 14, 1924. The yield green weight was 8.1 tons per acre.

grain ration. (Fig. 12.) For fattening both cattle and sheep it has given excellent results, but is most popular with the dairyman.

One source of pea ensilage is the refuse of pea canneries. This material is not often placed in a regular silo, but is stacked up green as it comes from the cannery and allowed to ferment in the stacks. This means, of course, considerable waste on the surface of the stacks, which, coming in contact with the air, always spoils, but 1 to 18 inches under the surface the material will be found packed down closely and in good condition if the stack has been well built (Fig. 13.) Feeding tests made with pea silage preserved in this way indicate a very high value, especially for dairy cows. It is estimated that about 61 per cent of the total of refuse vines from pea canneries is now made into silage, 21 per cent into hay, 12 per cent is used as green feed, and the other 6 per cent is either used as fertilizer or thrown away.¹

FIELD PEAS AS A GREEN-MANURE AND COVER CROP.

The field pea is well suited for use as a green-manure crop in orchards and is used quite extensively for this purpose in the citrus orchards of California.² (Fig. 14.) No other crop except vetch is so well adapted for this use in the southern part of that State. The chief objection to it has always been the expense of the seed. The larger varieties of the field pea require from 2 to 3 bushels of seed per acre, the average for all varieties being about $2\frac{1}{2}$ bushels. The price of seed which has not been hand picked and is therefore liable

¹ For more detailed information on this practice, see Crosby, M. A., Utilization of pea-cannery refuse for forage. U. S. Dept. Agr., Bur. Plant Indus. Circ. 45, 12 p., 3 fig. 1910.

² McKee, Roland. Orchard green-manure crops in California. U. S. Dept. Agr., Bur. Plant Indus. Bul. 190, p. 17. 1910.

of mixed varieties varies from \$1.50 to \$2 a bushel. This means that the seed alone for a green-manure crop will cost in the neighborhood of \$5 an acre. Common vetch, on the other hand, on account of its smaller seed, requires only 60 pounds of seed to the acre and entails an expense of not more than \$2.50 or \$3 an acre. When used for green manure the peas should not be plowed under until they have reached their maximum growth, unless other conditions connected with the main crop require that the plowing be done earlier. It is well to remember that the field pea continues to grow long after the first blooms appear, successive blooms being formed as the stem elongates. The most favorable time to plow the peas under will probably be reached, therefore, about the time the first pods are well filled.

The varieties selected for use as a green-manure or a cover crop should be those which are known to be adapted to the locality, and one with a good-sized vine is to be preferred over those that make a heavy yield of seed. The large Marrowfat peas, such as the Canadian Beauty, Arthur, Paragon, and Mackay, are well adapted for this purpose, as are also the Prussian Blue and Wisconsin Blue.

The use of a green-manure crop is profitable only in sections where sufficient soil moisture is present to cause the quick decay of the vegetable matter turned under. This prerequisite is supplied in southern California and other irrigated districts by the irrigation water. The immediate financial loss accompanying the use of green-manure crops in the Great Plains region is due largely to the inefficiency of soil moisture and the fact that the green-manure crop when it occupies the ground late in the season, using up the supply of moisture which would otherwise be available for the next crop.¹

Two varieties of field peas, the Gray Winter and the Austrian Winter, have shown considerable promise as winter-cover and green-manure crops on the Coastal Plains of the Southeastern States and the Pacific slope of Washington and Oregon. They have endured with only slight injury temperatures of -8° F. at Corvallis, Oreg., and -3° F. at Washington, D. C. Alternate freezing and thawing is more destructive to these peas than longer periods of intense cold. When not needed to plow under for soil improvement, the peas and clover in mixture may be used to advantage as an early hay crop. They should be sown the latter part of September or early in October, and in the Southeastern States especially inoculation seems to be necessary. The winter field pea makes a slower growth than the ordinary field pea and is therefore not so well suited for use in the citrus orchards of California.

Chilcott, E. C. Study of cultivation methods and crop rotations for the Great Plains area. U. S. Dept. Agr., Bur. Plant Indus. Bul. 187, p. 55, 70. 1910.

VALUE OF FIELD PEAS IN ROTATIONS.

The value of the field pea in rotations with hay, grain, and clover crops has been proved throughout the Northern States and also in a few localities in the mountain districts and irrigated valleys of the West. In the Northeastern and North-Central States, where rotations are regularly practiced, the field pea usually follows a meadow crop. This would seem to be the wrong place for it in a rotation because of the fact that nitrogen and humus are usually fairly abundant in the soil after a meadow has been plowed up. In practice, however, it is found that the crop of field peas is very effective in furthering the disintegration of the sod left by the grass. It is this fact which has determined its position in the rotation. The ground is left in especially good condition for a wheat crop, and the increase in yield of grain due to a preceding crop of field peas has been quite marked. The effect of the nitrogen added by a well-inoculated crop of field peas is shown by a decided increase in the amount of straw accompanying the larger grain yield of the following crop. This is well illustrated by the results at the Montana Experiment Station in 1903,¹ as shown in Table IV.

TABLE IV.—*Yields of oats following six crops, showing the beneficial effect of field peas.*

Crop on land in 1902.	Yield of oats in 1903.	
	Grain.	Straw.
	<i>Bushels.</i>	<i>Pounds.</i>
Field peas.....	106	3
Wheat.....	49	1
Clover.....	86	2
Barley.....	42	1
Sugar beets.....	82	2
Oats.....	64	1

The substitution of a crop of field peas for summer fallow in the wheat rotations of the Northwestern States is being advocated by agriculturists. It has been found that a crop of peas will leave the ground in practically as good condition for wheat as will fallow, and the yield of the succeeding crop usually is as good and in some cases better. Troubles from smut in the wheat also are less noticeable where wheat follows field peas. At the Sherman County Branch Experiment Station, Moro, Oreg., the average yield of four plats of spring wheat after field peas for four years was 40.2 bushels an acre, while the average yield of two adjacent plats of wheat after summer fallow during the same period was 38.5 bushels to the acre.²

¹ Atkinson, Alfred. Canadian field peas. Mont. Agr. Exp. Sta. Bul. 68, p. 86. 1907.

² Stephens, D. E., and Hill, C. E. Dry-farming investigations at the Sherman County Branch Experiment Station. Oreg. Agr. Exp. Sta. Bul. 144, p. 24. 1917.

DISEASES AND INSECT ENEMIES OF THE FIELD PEA.

Powdery mildew.—Powdery mildew¹ is usually most destructive to late-planted or late-maturing varieties of field peas. It is also confined rather closely to humid climates, where it sometimes reduces the yield considerably. The remedy lies for the most part in the rotation of crops, but where only small portions of a field are affected the disease can be controlled by spraying with Bordeaux mixture. If large areas are affected it is not economical to spray.

Leaf-spot or pea-blight.²—Another disease which has been troublesome in the pea-canning districts of both Wisconsin and Ohio³ is leaf-spot or pea-blight. This disease can be controlled in the same way as powdery mildew by spraying with Bordeaux mixture where the area affected is small, but in large fields the farmer must depend upon the rotation of crops. Although the disease is carried on the seeds, treatment of the seed with insecticides or hot water is not effective, because the germ of the seed is injured by the treatment more quickly than are the spores of the fungus.

Pea weevil.—The pea weevil⁴ is the most serious insect enemy of the field pea,⁵ and it has done more than anything else to limit the acreage devoted to this crop in Canada. According to Prof. C. A. Zavitz, Bulletin 126 of the Ontario Agricultural College, the acreage of field peas in Ontario in 1902 was just about half what it would have been if the weevil had not proved so destructive. There was a steady increase in area from 560,770 acres in 1882 to 896,735 acres in 1897, but from this time there was a gradual decrease to 532,639 acres in 1902. A constant increase in the weevils during this period is shown by the percentage of weevily peas in the Early Britain variety grown at the Guelph Experiment Station.⁶ These percentages were as follows: 1894, 2 per cent; 1895, 7 per cent; 1896, 11 per cent; 1897, 34 per cent; 1898, 49 per cent; 1900, 75 per cent; 1901, 96 per cent. After 1901 there was a decrease in the percentage, probably due to the fact that many of the farmers around Guelph stopped growing the field pea. The reduction of acreage in the Province continued, however, the average for the five years ended in 1923 being only 113,072 acres.

The pea weevil is a small grayish or brownish gray beetle, marked with lighter spots. The insect lays its egg on the young pod and the egg hatches out and produces a larva which bores through the pod of the pod and enters the young pea, where it feeds on the growing embryo and later pupates. The pupa remains in the seed until the next season, usually emerging from the pea the following spring, but the behavior of the weevils is unfortunately not uniform in this respect, many of them coming out sooner, so that the dates of emergence will range from harvest to planting time the following year. The remedy for the attacks of the weevil is to store the seed intended for planting in tight bags and hold it over for one year, in which time the beetle will emerge from the seed and die before the next

¹ *Erysiphe polygoni* DC.

² *Asochyta pisi* Lib.

³ Van Hook, J. M. Blighting of field and garden peas, chiefly due to seed infection.—Powdery mildew of pea. Ohio Agr. Exp. Sta. Bul. 173, p. 231-249, 12 fig. 1906.

⁴ Russell, H. L. Pea blight. In Wis. Agr. Exp. Sta. Bul. 228, p. 4-6, fig. 1. 1913.

⁵ *Bruchus pisorum* L.

⁶ Hittenden, F. H. Insects injurious to beans and peas. In U. S. Dept. Agr. Yearbook for 1898, 3-260, fig. 66-82. 1899.

⁶ Zavitz, C. A. The results of field experiments with farm crops, 1904. Ontario Agr. Col. and Exp. Sta. Bul. 140, p. 25. 1905.

planting season arrives. Another method employed by seedsmen to fumigate the seed with carbon bisulphid, which can be obtained at a reasonable cost from any druggist. In applying this remedy the seed must be placed in a tight box or barrel and exposed from 30 to 48 hours to the fumes of this liquid. The carbon bisulphid should be exposed in a shallow dish placed on top of the peas, since the vapor is heavier than air. This vapor when mixed with air is quite inflammable, and care should be taken not to ignite it in any way; otherwise, a serious explosion may occur. One pound of the liquid is usually considered sufficient to fumigate 100 bushels of peas, but it is well to use somewhat more than this in order to be sure of killing all the insects.

Continuous cropping of the land to the field pea is almost sure to mean a constant increase in the numbers of the pea weevil. Practically the only remedy for this state of affairs is to stop growing peas for several years, in which case the weevil will be exterminated through lack of food.

Attempts have been made to discover a substitute for the field pea which is not subject to the attacks of this insect. Among the legumes which have been tried for this purpose are the grass pea and the chick-pea. The weevil does not injure either of these peas, but they are not productive enough to make a profitable crop for the ordinary farmer, and the market for the seed is not sufficiently well established to guarantee him a dependable price.

Pea aphid.—Another insect which occasionally does considerable damage is the pea aphid, or plant louse.¹ It has appeared in pea-growing sections at intervals and practically destroyed the season's crop, but it does not stay with the crop so continuously year after year as does the weevil. The aphid increases rapidly during a period of warm, dry weather, but a heavy rain, even when the insect is abundant, will sometimes free the vines almost entirely from it. Unless some weather condition acts in this way to destroy the pest, the only hope of the farmer is for the parasites of the aphid to increase sufficiently in numbers to overcome and destroy it.

Pea moth.—This insect² has lately become troublesome in the pea-growing district of northeastern Wisconsin and is found occasionally also in Michigan.³ The moth appears soon after the pea vines begin to bloom, usually about July 14, and lays its eggs on the pods, leaves, and stems. The egg hatches in 7 to 10 days and the larva enters the pod and feeds on the seeds. Growth is completed in from 16 to 26 days, and the larva then emerges from the pod and passes the winter in the soil.

In the worst infested parts of Wisconsin 10 to 50 per cent of the pods were found to be attacked by the worms. Seed of such pods is practically useless for soup and much less desirable than clean peas for feeding to livestock.

The most effective remedy is to grow early varieties, seed as early as possible, thrash early, and then burn the rubbish left on the field.

¹ *Macrosiphum pisi* Kalt.

² *Laspeyresia nigricana* Steph.

³ Fluke, C. L., Jr. The pea moth: How to control it. Wis. Agr. Exp. Sta. Bul. 130, p. 12. 1920.

FARMERS BULLETIN 691 *Days*
UNITED STATES DEPARTMENT OF AGRICULTURE

GRASSHOPPERS AND THEIR CONTROL ON SUGAR BEETS AND TRUCK CROPS



SUGAR BEETS and garden crops grown in the semiarid regions of the States west of the Mississippi River are subject to frequent injury by several kinds of large native grasshoppers. The severity of this injury varies with the season and locality, but has been found to increase with the settlement of these regions. Especially is this the case where irrigated crops are surrounded by uncultivated pasture or waste areas where destruction of the egg masses during the winter is impracticable. Such crops naturally concentrate the grasshoppers from a considerably greater area, with serious injury as the result.

In view of the probability of increased losses from these pests, this bulletin has been prepared, which gives a sufficient account of the life history to afford thorough understanding of the control measures advised. Especial attention is directed to the value of neighborhood or community effort in controlling a group of pests originating, as do these, in areas from which extended migration is infrequent if not impossible. Given an intelligently applied and timely campaign by the entire community, each year that indications point to a serious grasshopper invasion, the losses from this source may be easily kept at a minimum.

Contribution from the Bureau of Entomology

L. O. HOWARD, Chief

Washington, D. C.

Issued November 11, 1915

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GRASSHOPPERS AND THEIR CONTROL ON SUGAR BEETS AND TRUCK CROPS.

F. B. MILLIKEN, *Scientific Assistant.*¹

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WHERE GRASSHOPPER INJURY IS MOST SEVERE.

MANY PARTS of the United States may suffer the loss or injury of crops through grasshoppers, but the area having an annual rainfall of less than 25 inches is especially subject to their attacks. This includes the country lying west of the Mississippi, with the exception of a strip from 100 to 200 miles wide bordering the river, and a portion of the northern Pacific States. In the eastern part of the semiarid region grasshoppers usually occur about equally in upland and lowland crops. In the drier sections farther west they have become established only along water courses and in other favored places where there is enough herbaceous vegetation to feed them through the summer. From here they spread immediately into localities developed through dry-land farming and irrigation.

Grasshopper ravages are relatively much more serious in dry regions than in humid, as the lack of moisture prevents recovery when crops are damaged. Recent outbreaks over most of this area

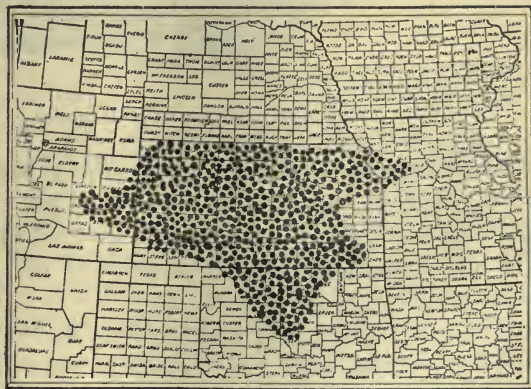


FIG. 1.—Map of Kansas and neighboring States, showing location of grasshopper outbreaks during the years 1911, 1912, and 1913.

¹ Resigned December 31, 1919; revision prepared by Truck-Crop Insect Investigations.

have been of native, nonmigratory species whose ravages are limited to crops in the neighborhood of their birthplace. As agricultural development is allowing them to extend their breeding grounds damage done by them is likely to increase unless measures to control them are adopted.

In 1913 the worst grasshopper outbreak in many years occurred in Kansas and adjoining States. As might be expected where there is little other tender vegetation, succulent sugar beets, sweet corn, onions, and rhubarb suffered severely. Taking the country over, all kinds of garden and truck crops were damaged. As a result, progressive growers during the succeeding years have been eagerly seeking preventive remedial measures.

DESCRIPTION OF THE MORE INJURIOUS KINDS.

The four kinds of grasshoppers which accomplished most of the injury to Kansas truck crops during 1911, 1912, and 1913 were the

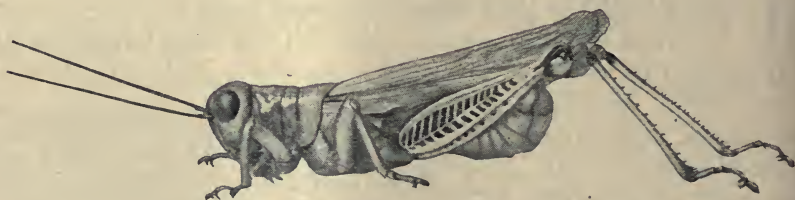


FIG. 2.—The differential grasshopper: Adult. Enlarged.

differential grasshopper,¹ the two-lined grasshopper,² the lesser migratory grasshopper,³ and one for which the writer knows no common name, but which, in view of its scientific name,⁴ may be called "the Bruner grasshopper." The adults of all four species intermingled during July and August.

The differential and the two-lined grasshoppers are the two large species having yellow bodies from 1 inch to 1½ inches long. The head and neck of the differential grasshopper (fig. 2) bear few if any dark markings, the forewings are uniform light olive-green, and the outside of each hind thigh bears a row of black V's that open backward, with a row of black dots just below.

The two-lined grasshopper (fig. 3) receives its name from the two yellow stripes that extend backward, one from each eye, across the neck and forewings, with a stripe of dark brown between. A black stripe on the hind thigh extends almost its entire length on the outside upper half, and the slender second joint is usually bluish-green.

The lesser migratory grasshopper derives its name from its re-

¹ *Melanoplus differentialis* Thomas.

² *M. bivittatus* Say.

³ *M. atlantis* Riley.

⁴ *Aeoloplus bruneri* Caudell.

resemblance in markings and habits to its destructive relative, the Rocky Mountain or migratory grasshopper. Its body is from three-fourths to 1 inch long, and is yellowish-brown with darker mark-



FIG. 3.—Two-lined grasshopper: Adult. Enlarged.

ings. There is a resemblance between this species and the red-legged grasshopper, which is found over about the same territory. The type may be recognized by the dark band on the front two-thirds of the upper half of the neck, a light stripe on each side from the base of the wing to the socket of the hind leg, and three dark bands across the top and down each side of the hind thighs. Through the center of each front wing a light stripe runs lengthwise, widening backward, and containing several squarish dark patches.

The thick-set body of the Bruner grasshopper (fig. 4) is about 1 inch in length and is of a greenish-yellow color. Three bluish-green stripes extend from the head backward across the neck, one on top and one on each side. The front wings are olive green, finely netted with yellow cross-veins, and with a wedge-shaped area lengthwise through the center, bearing light and dark patches. Three bluish-green zigzag stripes on the hind thighs extend across the upper surface and down on each side.

EGG LAYING.

Between the time of maturity, which differs for each species, and freezing weather the females deposit their eggs, selecting for this purpose firm soil in a well-drained location. A hole is formed by working the abdomen downward and backward into the soil as far as it will go, and the eggs are deposited therein, one at a time, as the abdomen is slowly withdrawn. (Fig. 5.) A white, frothy liquid, deposited with the eggs, fills the spaces among them and moistens the



FIG. 4.—The Bruner grasshopper: Adult. Enlarged.

walls of the hole. As the liquid dries, it hardens, cementing the yellowish-brown eggs and moist soil into a curved, cylindrical capsule. (Figs. 6, 7.) Abandoned fields, turn rows, the undisturbed



FIG. 5.—Differential grasshopper laying eggs. Enlarged.

last spring frosts, when warm weather is assured. The young grasshoppers push upward to the surface and soon begin feeding on the nearest vegetation. At first they are from one-eighth to three sixteenths of an inch long and almost white. Exposure to light and air soon develops dark patches in the skins, which make them difficult of detection when resting on soil or dead vegetation. In favorable weather the grasshoppers increase rapidly in size. The old skins stretch, are finally ruptured, and the young insects escape. This is the process known as molting and occurs five times before the grasshoppers are full grown. The newly acquired skins are very elastic for a short period after molting, and during this time there is a further rapid increase in size. The wing pads on the sides of the

strips under fence along neglected roadsides (see figure 8), and on banks of irrigating ditches and buffalo soil along the edges of infested fields are favorable places for egg laying.

DEVELOPMENT

The eggs hatch about the time of the

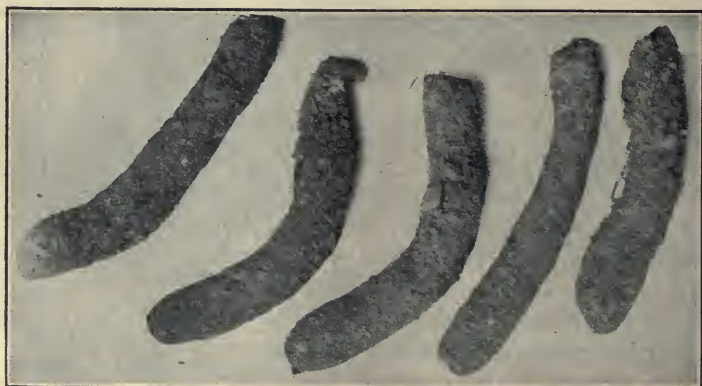


FIG. 6.—Egg capsules of the differential grasshopper, enlarged $1\frac{1}{2}$ times.

hoppers are full grown. The newly acquired skins are very elastic for a short period after molting, and during this time there is a further rapid increase in size. The wing pads on the sides of the

body above the legs become larger with each molt, the wings being fully developed after the last molt has taken place.

HABITS.

The young grasshoppers are most active on clear, warm days, during which they feed much of the time. At night and during cool days they seek shelter among standing vegetation or under rubbish and clods. They travel by jumping and crawling and are exhausted by slight exertion.

The adults of the lesser migratory grasshopper can fly long distances, but never do so except in search of food or to escape unfavorable conditions. The adults of the other three species mentioned have wings that are small in proportion to the size of their bodies and they can not fly far. Only a lack of food or very unfavorable surroundings will produce a migration to any great distance. Lack of suitable ground in which to deposit eggs may produce short migrations in all species, but it is probable that all of our injurious native species remain within 1 mile of their birthplace.



FIG. 7.—Egg capsules of the Bruner grasshopper $1\frac{1}{2}$ times natural size. 1, dorsal view; 2, lateral view; 3, ventral view; 4, dorsal view of eggs in capsule; 5, lateral view of eggs in capsule.

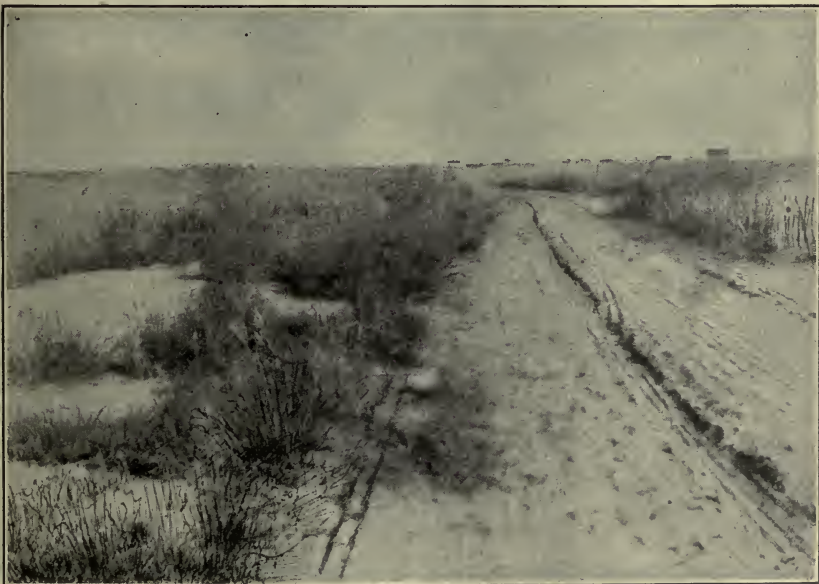


FIG. 8.—A neglected roadside. Russian thistles, sagebrush, and other weeds, interspersed with buffalo sod, form an ideal breeding ground for grasshoppers.

CLIMATIC CHECKS.

After grasshoppers become established in a locality they will not starve during an ordinary drought. The variety of plants they can use for food enables the young to mature if any vegetation starts in the spring. After maturity the adults can always find enough food to keep them alive until the eggs are laid.

When exposed to the sun on hot days, soft dirt, with hard dry soil below, reaches a temperature above 150° F. Grasshoppers cannot deposit eggs in such hot soil and therefore seek shaded ground for egg laying. This sometimes results in eggs being placed in poorly

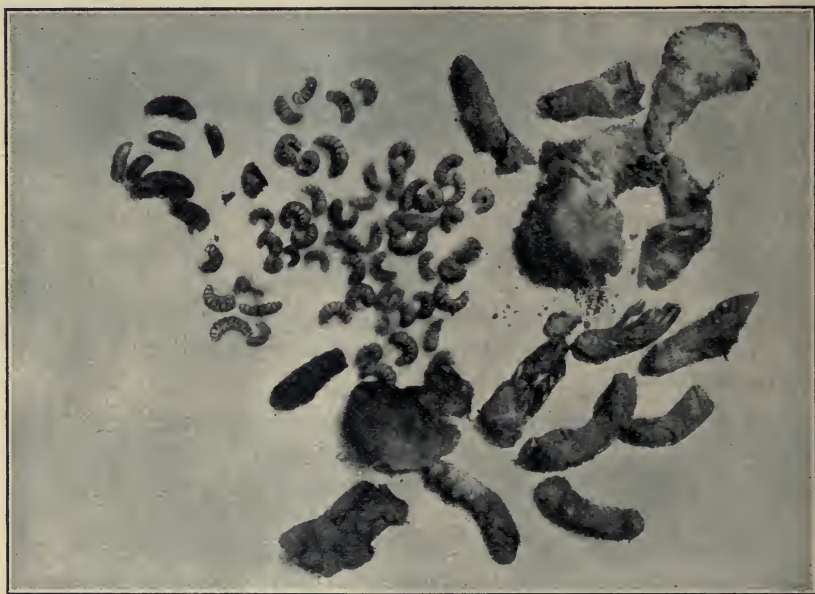


FIG. 9.—Grasshopper egg capsules and the bee-fly larvæ and coarctate larvæ of blister beetles that were collected along the roadside shown in figure 8; 53 of these parasitic larvæ were found in the grasshopper egg capsules collected in one hour. About natural size.

drained or heavy land, while others are placed in soil that becomes overheated later. In either case the vitality of the eggs is materially affected, often to the extent of being destroyed, as was noted during the hot weather of 1913, which was partly responsible for the reduction in the number of grasshoppers hatching the following year.

NATURAL ENEMIES.

ENEMIES OF THE EGGS.

Two of the most effective enemies of grasshopper eggs in Kansas are the larvæ of the bee flies¹ and those of blister beetles.² (See figs. 9 and 10.) These are white, grublike creatures that burrow

¹ Family Bombyliidae.

² Family Meloidae.

into the capsules when fresh and feed upon the grasshopper eggs until they attain full growth.

A small wasplike parasite,¹ from one-eighth to three-sixteenths of an inch long, has been reared from the eggs of the differential grasshopper, the two-lined grasshopper, and others. The female parasites cling to the bodies of female grasshoppers until the latter lay their eggs. As a grasshopper digs the tunnel in which to deposit her eggs the parasites crowd into it along her abdomen, and thrust their eggs singly, one into each grasshopper egg. The developing parasites then feed on the contents of the grasshopper eggs, destroying them.

Small rodents (mice, ground squirrels, and perhaps many others) and moles dig over egg-infested land, especially around the bases of weed stalks, to secure the capsules for food. Skunks share in this work, as indicated by the larger holes, footprints, and other traces. Hogs also eat the eggs and will turn the soil over thoroughly to obtain them.



FIG. 10.—Blister beetles: Coarctate larvæ (winter stage) of several species, $1\frac{1}{2}$ times natural size. At bottom are two as found, partly within the grasshopper egg capsules. Most blister-beetle larvæ before transforming burrow some distance from the egg capsules in which they feed.

ENEMIES OF THE YOUNG AND ADULTS.

A red mite, which is reported to have destroyed many of the Rocky Mountain grasshoppers during the seventies, does not kill

¹ *Scelio monticola* Brues.

many of our native species. The writer counted 135 of these mites on a single adult grasshopper which was still very active.

Young grasshoppers are frequently stung by female wasps, paralysis follows, and they are then stored to nourish the wasp larvae. Several dozen helpless young grasshoppers have been dug from a single wasp burrow. The larger spiders as well as ground beetles feed on such grasshoppers as they can secure. Parasitic flies deposit their eggs or living young on the grasshoppers and the maggots enter the body and feed until grown, when they tear their way out, killing the grasshopper. These flies become very abundant in the fall of years of severe grasshopper outbreaks.

Toads, practically all lizards, and some snakes, feed to a considerable extent on grasshoppers. Cats and ground squirrels have been seen to catch and eat those of the larger species. Birds, practically all of which feed upon grasshoppers, destroy large numbers of both young and adults.

In some places chickens, turkeys, and guinea fowl are raised to catch them, constituting one of the most practical means of checking their outbreaks.

The chinch-bug fungus is known to kill large numbers of grasshoppers. In localities of eastern and central Kansas the differential and two-lined grasshoppers were almost wiped out by this disease during the fall of 1911. While the Bruner grasshopper was maturing during June of 1913, many nymphs and adults were killed by it. Reports of grasshoppers dying in western Kansas during the same period indicated a widespread outbreak of the disease. Its presence among the grasshoppers is easily recognized, as the dead insects remain clinging to the tips of weeds and grass, sometimes several in a cluster.

CONTROL MEASURES.

The control measures herein recommended are the most effective that were tried in Kansas during the years 1911 to 1914, and when carefully applied the value of the crop saved will be several times the cost of application. These measures come under two heads: (1) Destroying the grasshopper eggs, and (2) destroying the young and adult grasshoppers.

DESTROYING THE EGGS.

PLOWING.

If egg-infested land requires plowing for the next crop, no other treatment need be given. The plowing should be at least 6 inches deep, however, and should be finished as much before April 15 as possible. This covers the eggs so deeply that the young can not get out when they hatch.

HARROWING AND DISKING.

If plowing is unnecessary for the following crop, the eggs can be destroyed with little expense by stirring the ground to a depth of about 2 inches by March 1. This breaks and crushes many capsules and exposes others to the attacks of enemies and disease, as well as to drying and freezing. In clean ground that is soft enough a heavy harrow will stir the soil sufficiently. Three or four sections drawn by five horses will cover the ground rapidly. In heavy soils, weedy fields, alfalfa, or land in which patches of sod occur, the disk harrow is required; but in alfalfa it should not be set deep enough to cut off the crowns of the plants. The land should be left rough to expose as many eggs as possible, and after hard freezing weather it should be harrowed to expose any eggs that may have been covered before.

It is difficult to destroy eggs in buffalo sod. Breaking is not usually done deep enough to keep the young from escaping or the slices of sod are not left close enough together. No other cultivation can be given sod land. Hogs will root out and eat some of the eggs, but their use is not practicable for a large area. The egg-infested sod should be left until the young have hatched, when they can be killed by burning or by one of the other methods recommended for their destruction. Scattered clumps of egg-infested grass in turn rows, under fences, in abandoned fields, or along roadsides should be chopped out before March 1 with a heavy hoe or a spade.

DESTROYING THE YOUNG AND ADULT GRASSHOPPERS.

POISONED BRAN MASH.

Poisoned bran mash has been used against grasshoppers for many years with varying success. In 1911 and 1912 the writer, then with the Kansas Experiment Station, tested different methods of preparing and applying it, the results indicating that the addition of citrus fruits made it much more attractive to grasshoppers and that when sown broadcast one application killed from 50 to 100 per cent of those on the treated land. These results were confirmed during the severe grasshopper outbreak of 1913, more than 1,000 tons of bran being used in Kansas alone. Since then the formula has been used throughout the United States and Canada with uniformly good results. Other investigators have discovered that sawdust may be substituted for half or more of the bran and that where citrus fruits (oranges, lemons, and limes) are not available, tomatoes, canteloupes, melons, bananas, and perhaps other substances may be used to advantage.

The standard formula is given below, with the quantities of ingredients that are most conveniently handled under farm conditions. As much water should be used as the bait will hold without any draining off and wasting the poison. In arid sections and when it

is very dry this will be as much as 1 gallon to 6 pounds of bran, but this varies when substitutes are used instead of bran, and is always less in humid regions.

Bran	-----pounds	25
Paris green or white arsenic	-----pound	1
Oranges or lemons	-----quarts	6
Cheap sirup or molasses	-----quarts	2
Water	-----gallons	3

Mix the dry bran and poison in a washtub. Add the sirup and the juice and finely chopped pulp and peel of the fruit to the water. Then pour the water over the mixture of bran and poison, stirring to dampen it thoroughly and add as much more water as the bait will hold, usually about 1 gallon. While fresh, the wet fruity mash is very attractive to grasshoppers; but when dry or stale it is not eaten. The bait is applied by sowing it broadcast on the infested land late in the evening or early in the morning. Very early morning is to be preferred, as the grasshoppers are then just beginning to feed, and they have a longer time to eat before it dries than if it were applied at any other time. The bait should not be spread just before a shower, as rain washes the poison from the bran flakes, leaving them harmless. Little of the bait is eaten after the first day, even in damp weather. Therefore several applications may be necessary to check damage by grasshoppers in badly infested fields, or to keep injurious numbers from drifting into a field.

The amount of bait prepared by using the quantities of ingredients given in the formula will sow 6 acres of heavily infested land. This makes the cost of one application about 25 cents per acre. Ordinarily this amount should be spread over about 12 acres, which reduces the cost to 15 cents per acre or less. When the bait is to be applied a small quantity of known weight should be mixed and sown that it may be ascertained how very little is required when only 2 to 4 pounds of bran are to be used to the acre.

Cautions.—Neither domestic animals nor birds can secure enough of the poisoned bait to kill them, if it is scattered evenly as directed. Nevertheless, a few cautions regarding its use may not be out of place. It should never be placed in heaps or scattered thickly. The poison and mixed bait should be kept out of the reach of children and of domestic animals. Utensils used in handling the bait should be thoroughly scrubbed before being used for any other purpose. The dry, powdery poisons should not be exposed to the wind or handled roughly or carelessly. The bran and poison should be mixed with a spade or wooden paddle. If the hands are used for this purpose enough poison may be absorbed by the back of the hands and the forearms to cause severe intestinal cramps and diarrhea. The writer, however, has never known poisoning to occur simply from sowing the wet bait barehanded.

Where large areas have to be covered or when time is extremely limited, a device improvised during the grasshopper campaign in western Kansas, in 1916,¹ will materially reduce the labor required in applying poisoned bran mash. The apparatus is constructed after the manner of an alfalfa seeder used in that section and has many times proved its value, one man covering as much ground with it as three men distributing poison by hand.

The distributor (fig. 11) consists of a canvas bag which is strapped over the shoulders of the operator and is fitted with a feeding device consisting of a canvas sleeve and a swinging tube made of tin or galvanized iron, as shown in the drawing. A closely woven grain sack furnishes fairly good material for the bag. By careful experimentation it has been found that a machine constructed as here described scatters the mixture properly and evenly and covers ground rapidly. The bag may be made of a convenient size. The dimensions of the metal tube are as follows: Length, 28 inches; diameter at upper end, $2\frac{1}{2}$ inches; diameter at lower end, $1\frac{5}{8}$ inches. Over the opening at the lower end are soldered two short wires bent in the shape of a U and crossing each other at right angles at exactly the center and about 1 inch below the opening of the tube. These should be soldered both to the edge of the tube and together where they cross. Their purpose is to scatter the mixture evenly and thinly as it leaves the tube, which is swung by the operator. The canvas sleeve is 12 inches long, 13 inches in circumference at the upper end, and 8 inches at the lower end, which fits tightly over the upper end of the metal tube. These dimensions allow the mixture to work down into the tube and permit the tube to be swung over the half of a circle by the operator when walking through the field. On a still day the poisoned bran mash in this way may be scattered evenly and thinly over a strip of ground 60 feet wide. This enables one to cover an infested field in a short time and to do the work very thoroughly. A distributor of the foregoing dimensions will distribute poisoned bran mash at the rate of about 5 pounds to the acre, which is recognized as an efficient dosage under western Kansas conditions. The mixture can be sown thickly or thinly, depending upon the rapidity with which the operator walks through the field. Where grasshoppers are very numerous, by walking slowly and whirling the

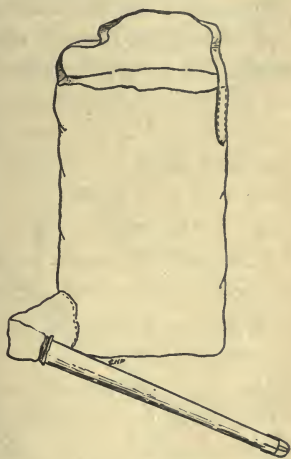


FIG. 11.—Distributor for poisoned bait.

¹ Brooks, T. H., *Journal of Economic Entomology*, vol. 10, p. 524, 1917.

tube regularly, the mixture can be applied much more thickly than where the grasshoppers are less abundant and where a natural gait is maintained by the operator. *It is necessary to have the oranges or lemons used in the bait ground through a meat chopper in order to prevent the tube from becoming stopped by the peelings in case this machine is used.*

THE HOPPERDOZER.

The hopperdozer is an old device for using kerosene, crude oil, or tar in catching grasshoppers and was developed during the migratory grasshopper years of 1874–1876. It consists of shallow sheet-iron pans, containing the oil or tar, which are mounted on low wheels or sled runners. An upright screen at the back catches the "hoppers" as the machine is drawn forward.

The hopperdozer is simple in construction. (See fig. 12.) The pan is made by turning up 6 inches of the edge of a sheet of galvanized iron, 8 feet long and 30 inches wide. Two inches of the edge is then turned down over the pan to prevent slopping, and two partitions soldered across it to keep the liquid from running to one end and spilling when operated on sloping ground. The sled floor is 18½ inches from front to rear, being made of one board 1 by 6 inches and one 1 by 12 inches with a narrow

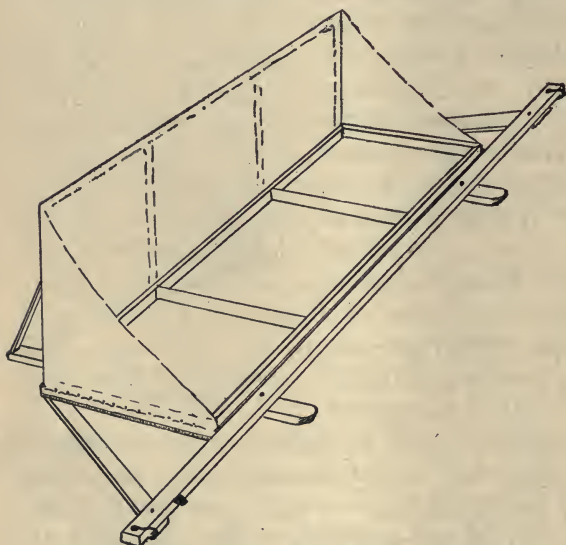


FIG. 12.—A successful type of horse-drawn hopperdozer.

space between. It can be either 8 or 15 feet long to hold either one or two pans. A strip 1 by 4 inches on edge around it keeps the pans from sliding off. The runners are pieces of 2 by 4 lumber 4 feet long, laid flat and rounded at the front ends. They should extend about equal distances in front of and behind the floor. An 8-foot sled needs two runners and a 15-foot sled needs three. The screen behind the pans should be of oilcloth, smooth side forward, nailed to uprights at the back of the sled. The hitch is made by nailing a 2 by 4 across the runners in front of the pan and letting

the ends project 2 or 3 feet at each side. Each end is braced by a board extending to the end of the runner behind the pan.

For use, the compartments of the pan should be half filled with water and enough kerosene or crude oil should be added to form a film. If tar is used, a thin layer is spread in the bottoms of the otherwise empty pans. As the hopperdozer is drawn forward the grasshoppers jump up and fall into the pan, or strike against the screen at the back and drop in. Contact with a little tar or a wetting with the oil kills them, even though they jump out afterwards. The dead that collect must be shoveled out at intervals and the tar or oil and water replaced.

When large fields of fairly level land are to be treated with the hopperdozer, two or three pans are often set on the teeth of a sweep rake. This makes the work easy for the team, but on rough ground the liquid slops badly. In such cases two sleds holding two pans each, having for runners pieces of 2 by 4 set on edge, should be placed end to end. The two adjacent runners should be loosely bolted together through a 2 by 4, which is placed on edge between them. The middle 2 by 4 should project behind from 4 to 5 feet, and from its end a strong wire should be stretched to the outer back corner of each sled. This wire and the 2 by 4 brace the "double" hopperdozer so that it can be drawn by two teams, one hitched at each end. Being flexible in the middle, it can be used on very uneven ground that will sometimes throw the ends much higher or much lower than the middle. Of course the screens at the back must be arranged so as not to interfere. The wide sweep (30 feet) of this hopperdozer enables the ground to be covered rapidly, which is very important during severe outbreaks, and the teams are so far apart that they do not drive many grasshoppers before them.

An improved hopperdozer, which has been called the grasshopper catcher and which eliminates the disagreeable features incident to the use of crude petroleum, tar, and other sticky substances, has been devised for use in Utah.¹ This machine can be run over hay and grain crops, sugar beets, and potatoes; in fact, over practically everything except corn and ripening grain. It has been used quite successfully on seed alfalfa by running over the field about every 10 days. The details of the machine as illustrated (fig. 13) should enable anyone to make one of them without difficulty.

The principle of the machine is very simple—a box about 2 feet square and 16 feet long on runners, and a 2 by 4 extending out 4 feet at each end, to which a horse is attached. The horses then travel 24 feet apart, driving the grasshoppers in until most of them are in front of the 16-foot machine. A rope fastened to the hame on the inside of each horse and dragged just in front of the machine

¹ Ball, E. D., Utah Agricultural Experiment Station, Bul. 138, pp. 108 to 111.

causes the "hoppers" to jump just as the machine gets to them. The front of the machine is made of tin and is about $2\frac{1}{2}$ feet high and slightly curved. This front does not extend quite down to the bottom, and about 2 inches in front of it and about 4 inches high there is a false front, a second piece of tin, which curves back down and into the box. A grasshopper hitting the tin face can not get foothold, is perfectly helpless, and slides down between the two pieces of tin, strikes the curve, and is thrown well back into the box far enough so that he can not see the opening through which he entered. The top and back of the box are made of wire mosquito netting and the hopper immediately jumps toward the light and clings to the netting, never seeking the hole through which he came in.

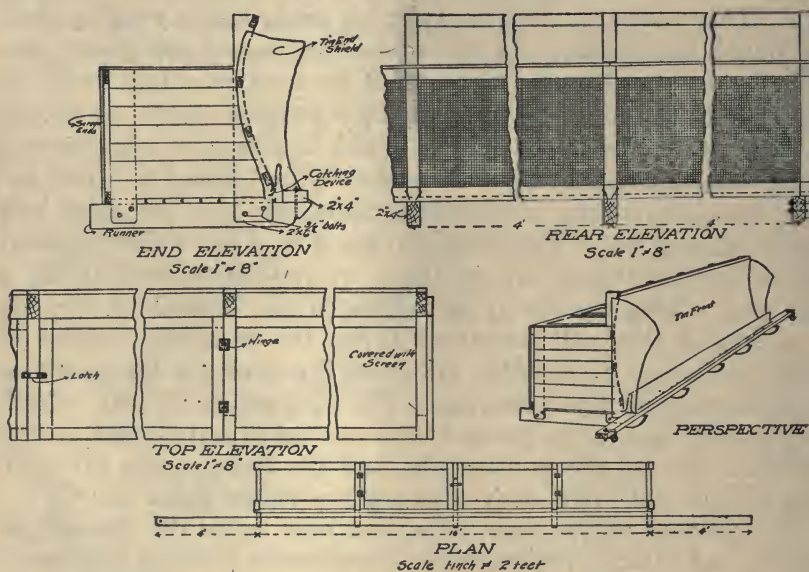


FIG. 13.—An improved machine for catching grasshoppers. (Ball.)

Several bushels can be gathered in this way before they will shake down onto the bottom sufficiently to choke up the front opening. As soon as this happens the front opening should be closed with gunny sacks or similar material and the hoppers can be shoved out into sack and used to feed chickens or dumped into a trench and buried. As a temporary substitute for the tin front oilcloth may be used. A 6-inch board, hinged to the bottom of the box and extending the full length, about 5 inches back of the front, could be arranged to fold down and close the front while at rest, or stand up at a slight angle to keep the hoppers from rolling down and choking the opening.

The material for such a machine will cost about \$20, and anyone with a saw and hammer can make one in a very short time. The

runners should be spaced so as to fit sugar beet or potato rows, if the machine is to be used on these crops.

A machine, if protected, will last for years, and, as it takes 24 feet at a sweep, it will cover 40 to 50 acres in a day. As there is no expense to the operation except the team and a man to drive, or preferably two small boys to ride the horses, the cost per acre is trifling.

It is not possible to catch all the grasshoppers by going over a field once, but under favorable conditions a very large percentage of them can be caught. If the crop is fairly high the best time to catch the grasshoppers will be in the morning and evening. At these times they are roosting and are quite sluggish. On low crops the hot part of the day, when the grasshoppers jump readily, will be the best time. If the tin front is kept bright and shiny the grasshoppers apparently are not able to see it at all and fly against it readily. Six to 10 bushels of grasshoppers have been collected in an hour with one of these machines where the insects were numerous and conditions favorable, and 30 to 40 bushels a day taken from fields where they did not appear to be very abundant.

BURNING.

Sometimes many grasshoppers hatch in dead vegetation, where they can be destroyed by burning. This frequently occurs on buffalo sod, in neglected fields, or along roadsides. Burning is then the cheapest and most effective means of killing them. If there is not enough dead vegetation to carry the fire, some old hay or straw scattered through the infested area will help to produce enough heat to kill the insects. Opportunities for destroying native grasshoppers by burning should not be neglected. A sufficient number can hatch in one-fourth of an acre of sod to ruin a neighboring garden, yet half a day's work and a load of straw or old hay would burn them all.

UTILIZATION OF POULTRY.

Where grasshoppers are an annual pest, farmers can protect their crops and make a profit on the insects by raising poultry to catch them. The value of chickens and turkeys in destroying grasshoppers is proved anew by each succeeding outbreak, yet comparatively few farmers utilize them as a means of control.

During the late nineties many turkeys were raised to catch grasshoppers on the valley lands along the Solomon River in northern Kansas. Children herded the flocks where grasshoppers were the most destructive, and so successful was this method of saving crops that more farmers adopted it every year until that series of grasshopper outbreaks ended.

Near Scott City, Kans., during 1911, the second crop of alfalfa on a 100-acre field was badly damaged. The owner secured about 100 turkeys and turned them into the field. When the writer visited the place during the third week of August a few of the lesser migratory grasshoppers that could escape capture by flight were the only ones present. The alfalfa was uninjured and was then about 18 inches high.

In June, 1912, the writer constructed a portable henhouse for about 36 grown chickens. It was located on or along the edges of grasshopper-infested fields, being moved to a new place when no "hoppers" were left near by. This flock was fed only a little grain, and while not quite so many eggs were obtained from the hens in comparison with hens handled in the ordinary way, many grasshoppers were caught and the hens acquired such a taste for them that upon being returned to the barnyard they ranged far and near in search of insects.

The Kansas Experiment Station at Garden City bought several hundred chicks in an effort to save the crops during the severe grasshopper outbreak of 1913. A wooden framework, on low trucks, constructed of 2 by 4 material, was built and covered outside with poultry netting and inside with canvas. This portable chicken house was easily hauled from place to place, and was considered the most effective means yet adopted in destroying grasshoppers.

During 1913, near Garden City, rhubarb was attacked by grasshoppers that were rapidly stripping the leaves. The gardener placed in separate coops near it three hens with a total of about 40 active chicks. A few days later the rhubarb was free from grasshoppers and the chicks were catching others in adjacent parts of the garden.

UTILIZATION OF HOGS.

Hogs of all ages become very fond of grasshoppers whenever they are allowed the run of infested land. They are reported as efficient destroyers of both grasshoppers and their eggs. A small lot in a field which had been left for alfalfa seed was fenced as pasture for a few hogs. Grasshoppers damaged the entire field except in the hog lot, where a good crop of seed was set.

PROTECTING SUGAR BEETS, TRUCK CROPS, AND GARDENS.

Land prepared for sugar beets is usually plowed more than 10 inches deep. This is often done late in the fall or early in the winter. Throughout the summer the growing beets require frequent cultivation, which drives away grasshoppers that wish to lay eggs. Digging the beets in the fall stirs the surface soil so much that any egg capsules in it are injured or exposed. Only along the edges of fields and, in irrigated districts, on the banks of ditches is there any danger of eggs being left undisturbed.

Many truck and garden crops are grown on land that is plowed deep late in the fall or during the winter. They also require frequent summer cultivation and, with some, the ground is stirred by harvesting. Consequently there is not much danger that grasshoppers will lay eggs in such fields. From the facts mentioned it is evident that grasshopper damage to sugar beets, truck crops, and gardens is the result of invasion from adjoining infested land.

If many grasshoppers are present during August and September a search should be made to locate their eggs. Clumps of grass should be chopped out and torn to pieces. Here and there in suspected buffalo sod a square foot of ground should be examined to a depth of about 2 inches for eggs. Where the soil is more easily worked the spaces examined may be a yard square. An average over a large area of one capsule of eggs per square yard means a severe outbreak the next year. From each capsule that remains sound 25 to 150 young may hatch. Spots well suited to egg laying are often more heavily infested than this.

When the eggs have been located, measures for their destruction can be applied. These should be delayed until the parent grasshoppers die, in order that no more eggs may be deposited. If the egg-infested land requires plowing for the next year's crop, no other treatment need be given. When plowing is not required, the harrow or disk may be used. Suitable treatment should be given the edges of fields, ditch banks, turn rows, abandoned fields, roadsides, or any other places where eggs are to be found. Scattering clumps of egg-infested grasses should be uprooted, even when the surrounding land receives no treatment.

Where the eggs can not be destroyed, the infested area should be watched and the young killed when they hatch in the spring. On waste land, pastures, and sod that can be burned over, fire is the best means of destroying them. If it can not be used, and young chicks or turkeys are available, these should be put into a portable henhouse and located between the infested land and any field into which the young grasshoppers are likely to go. The flock can be moved to a fresh location as the land near by is cleared of "hoppers." In this way the grasshoppers can be worked back from the field and the danger of invasion lessened. If the infested area is large, the poultry may be brought almost to maturity with a comparatively small outlay for feed and with a constantly decreasing number of grasshoppers that will be left to deposit eggs in the fall.

There should be no delay when grasshoppers hatch in great numbers over a large area, for the expense and difficulty of combating them increase rapidly as they grow larger. If no other means of control are ready for use at once, the poisoned bait or the hopperdozer must be relied upon. The time available for the work, the cost of ap-

plication, and perhaps other factors must be considered in choosing between the two methods. The bait is cheaper, less time is required to treat land with it than with the hopperdozer, and it can be prepared in any quantity. With a 2-gallon pail of bait one can sow in fields and in locations the character of which makes the use of the hopperdozer impossible. Consequently this method is most frequently chosen.

If grasshoppers have already invaded a beet field or garden, the bait must be applied all over it. Several applications at intervals of two days are sometimes necessary to check the injury. The infested land from which the grasshoppers are coming should also be treated vigorously with the most suitable method. Around the edges of fields, and in fields where the crop permits it, a tubful of bait can be placed on a sled or in a wagon, and the driver can sow from it, thus getting over the ground rapidly. The "hoppers" in fields of low-growing crops can be caught with a hopperdozer if time permits and teams are available. But in fields of tall-growing crops, where many grasshoppers are on the plants at all times, a modified bait should be used. It is prepared by using three or four times the usual quantity of sirup and correspondingly less water. It should be applied by throwing small quantities among the tops of the plants so that it will stick to the leaves or blades. There it will attract the grasshoppers immediately. The poison is washed off by rains or shaken off by handling, so there is no danger to animals that feed on crops treated in this manner. This sticky bait should also be thrown among the tops of bushes or trees in which the insects feed.

ESSENTIALS FOR SUCCESSFUL WORK.

The most frequent cause of failure to check grasshopper outbreaks when methods of control are applied are (1) lack of cooperation among the landowners of the infested community and (2) misdirected or careless application of recommended control measures. The former, however, is more often the cause.

In many localities part of the land is held by speculators, who often permit it to lie idle for several years in succession. If such land is in sod, grasshoppers use only the outskirts for depositing eggs, but if it has been broken and then neglected, a sufficiently heavy growth of weeds is often produced to make it a breeding place for large numbers of grasshoppers. Where there is much of such land in a community the grasshoppers must be destroyed on it, as well as on the edges of cultivated fields, along roadsides, or on pasture land; otherwise it becomes the center from which "hoppers" scatter to the crops on adjoining fields.





Temp.

UNITED STATES DEPARTMENT OF AGRICULTURE



FARMERS' BULLETIN



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Contribution from the Bureau of Biological Survey, Henry W. Henshaw, Chief.

GAME LAWS FOR 1915.¹

A SUMMARY OF THE PROVISIONS RELATING TO SEASONS, EXPORT,
SALE, LIMITS, AND LICENSES.

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INTRODUCTION.

SCOPE OF THE BULLETIN.

The present bulletin, containing the sixteenth annual summary of the game laws of the United States and Canada, has been prepared on the same general plan as those issued each year since 1902. It includes a summary of the more important features of the new legislation, a brief synopsis of the new game laws enacted in each State and Province, and a series of tables showing the provisions relating to seasons, export, sale, limits, and licenses. It differs from other publications on game laws in several important points: (1) Inclusion of a brief review of the measures enacted, (2) arrangement

¹ This bulletin contains the proclamation of the President and the amended Regulations for the Protection of Migratory Birds, approved Oct. 1, 1914.

of provisions by subjects instead of by States, and (3) adoption of a uniform statement and order of the various details to facilitate comparison of similar provisions in different States. Its chief objects are to present in convenient form the restrictions on hunting which affect the enforcement of the Federal statutes regulating interstate commerce in game and the protection of migratory birds, and to show the general condition and trend of legislation from year to year. Provisions relating to methods of capture, game refuges, enforcement of laws, disposition of fines and fees, and matters of special or local application are omitted. These can be found only by reference to the laws themselves or to the pamphlet editions of the game laws, obtainable in most States from the proper officials.¹

REVIEW OF LEGISLATION OF 1915.

More than 240 new game laws were enacted during 1915—a larger number than in any previous year except 1911. Forty-three States held regular legislative sessions, and in all of these States except Arizona, Georgia, and Nebraska some changes were made in the statutes protecting game. The largest number of new game laws passed in any one State was 61, in North Carolina; but in California, Connecticut, Maine, New Jersey, Oregon, Pennsylvania, and Wisconsin the number reached 10 or more. Several measures were vetoed, including a general game bill in Idaho, the first bill appropriating the hunting-license fund in Pennsylvania, a bill protecting bears in California, and three sections of the game bill in Washington. A number of bills were introduced for the purpose of harmonizing the State laws on migratory birds with the Federal regulations. In at least nine States changes were made which brought the seasons into substantial agreement, viz, California, Connecticut, Maine, Michigan, New Hampshire, Tennessee, and West Virginia; in Illinois the seasons for all migratory birds except coot and waterfowl, and in Washington for the smaller shore birds, were made to conform with the regulations under the Federal law. Uniformity was also secured by provisions in the laws of Connecticut, Maine, New Mexico, North Dakota, Washington, and Wisconsin, prohibiting hunting between sunset and sunrise. On the other hand, Delaware adopted a resolution opposing the migratory-bird law, and Ohio and Rhode Island, which had harmonized their seasons in 1914, changed the laws on waterfowl this year.

As a result of the decision of the Supreme Court of the United States on January 19, 1914, sustaining the alien hunting law of Pennsylvania, legislation prohibiting aliens from hunting or owning shotguns or

¹ See p. 64. Names and addresses are given in the Directory of Game Officials, published by the Biological Survey, U. S. Department of Agriculture (edition of 1915, B. S. 101).

rifles was enacted in at least four States—Massachusetts, New Jersey, North Dakota, and West Virginia—but certain exceptions based on property qualifications were made in Massachusetts and New Jersey.

Close seasons extending for several years were provided for certain kinds of big game and also for game birds. Hunting mountain sheep was suspended in Idaho, Montana, and Washington, and goats were protected until 1918 in Montana. Moose were protected for four years in Maine, the first absolute close season on this species for 35 years—since the suspension of hunting from 1878 to 1880. Antelope were given absolute protection in New Mexico and Montana. In Michigan, New Mexico, and Oklahoma prairie chickens were protected for several years. Michigan extended complete protection also to quail, imported pheasants, grouse, and wood ducks for five years. Minnesota protected doves, woodcock, plover, and wood ducks until 1918. New Mexico gave protection to pheasants, bob-whites, pigeons, and swans. Oklahoma protected doves, grouse, wood ducks, and curlew. Several birds were removed from the game list and protected throughout the year. Oklahoma gave such protection to pelicans, gulls, and herons. Tennessee declared ring-neck pheasants, bullbats, robins, and meadowlarks to be nongame birds. In a few cases protection was removed from certain species—notably the turkey buzzard in Delaware, Florida, and North Carolina; owls and starlings in New Hampshire; and cormorants in Illinois and North Dakota.

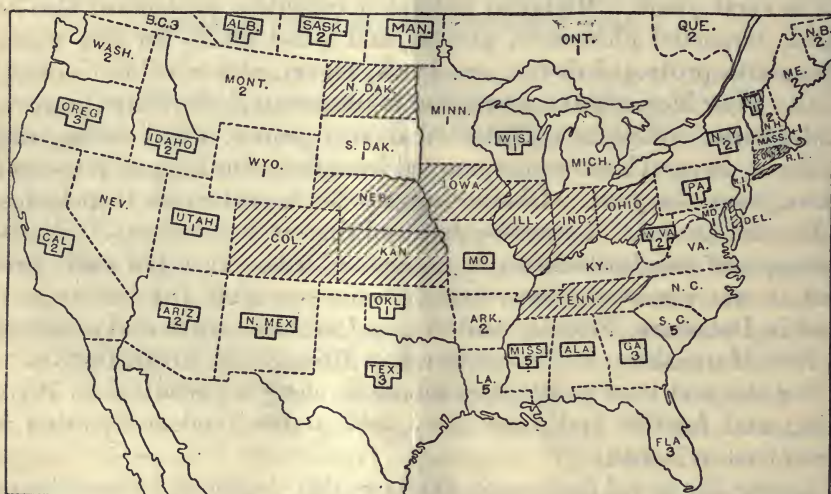
For the first time in 12 years moose hunting is permitted in Wyoming, and for the first time since 1907 prairie-chicken shooting is permitted in Indiana.

Among the novel features in the laws this year may be mentioned the declaration in the Florida law that ownership of game is vested in the respective counties; the provision in the California law protecting spike bucks, or deer with unbranched horns, instead of deer with horns of a certain length; and the Wyoming experiment of allowing the killing of 50 bull moose under \$100 licenses instead of an indefinite number during a limited season. Methods of hunting were restricted in Michigan by prohibiting the use of automobiles in hunting partridges, and in Indiana by prohibiting the use of searchlights or other artificial lights attached to autos for hunting game on or near a highway. Several new restrictions on shipment appeared for the first time: Illinois prohibited importation from points outside the State of any game except deer legally killed. Pennsylvania prohibited shipment of game by parcel post, and Wisconsin, shipment under an alias. Connecticut authorized the commissioners of fisheries and game to grant permits to bring in game lawfully killed outside the State, provided such game is not offered for sale.

BIG GAME.

The more important changes affecting big game included the closing of the season for four years on moose in Maine; authorization for the killing of 50 bull moose in Wyoming; lengthening the season on elk in Montana two weeks; closing the season on mountain sheep in Montana; changes affecting does in 8 States, including the removal of protection¹ in Florida, Nevada, New Jersey, and Wyoming; establishment of a limit in Arkansas; and decrease in the limits in Alaska, Michigan, Montana, and Nevada.

Under present conditions deer hunting is permitted in 36 States, in about one-third of which the hunter is limited to one deer a season and in most of the others to two. Seventeen States protect does at all



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FIG. 1.—States and Provinces which permit deer hunting, protect does throughout the year, and limit the number of deer which may be taken by each hunter.

[Shaded areas indicate the States in which there is no deer hunting; inclosed names, the States which protect does at all seasons, and figures, the number of deer allowed each hunter during a season. In the eastern half of Maine and southern half of New Hampshire the limit is 1 a season. In Alabama, Mississippi, and Missouri the limit is 1, and in Louisiana 2 per day.]

seasons and allow only bucks to be killed—namely, Alabama, Arizona, California, Georgia, Idaho, Missouri, Mississippi, New Mexico, New York, Oklahoma, Oregon, Pennsylvania, Texas, Utah, Vermont,¹ West Virginia, and Wisconsin. Pennsylvania requires that deer killed shall have horns 2 inches above the hair, New York and Vermont, at least 3 inches long, and West Virginia, 4 inches long, while California prohibits entirely the killing of spike bucks.

QUAIL.

Notwithstanding the agitation in favor of protecting quail for several years in some sections, no bills of this kind were passed this year, and 38 States still provide quail shooting. The seasons were

¹ Vermont has suspended the restriction during 1915.

shortened six weeks in Oklahoma and two weeks in Nevada. Limits were established for the first time in Arkansas and New Hampshire, reduced in Iowa from 25 to 15 per day, in Oklahoma from 25 to 10, in Minnesota from 15 to 10, and increased in Nevada from 15 to 20. All but 14 of the States which permit quail hunting now have a limit of 20 birds or less per day.

WATERFOWL.

All the States now allow waterfowl hunting, but the wood duck is protected for several years throughout the northern zone and in the southern zone in the States of California, Kansas, and West Virginia. Daily bag limits were established for the first time in Arkansas and Connecticut, reduced in Oklahoma from 25 to 10, and increased in Missouri from 10 to 15. Most of the States now have a limit of 25 or less per day.

OPEN SEASONS.

Open seasons were lengthened in Montana on elk and deer two weeks; in Florida on deer and birds three weeks; in Minnesota on quail 20 days; and in Nevada on sage hens four and a half months, on grouse one month, and on quail two weeks. New Jersey reverted to the former plan of hunting deer on four consecutive Wednesdays instead of five consecutive days.

Seasons were shortened in a number of States. In the case of big game the deer season was curtailed in Arkansas three months; in Oregon and Washington two weeks. In New Mexico the seasons were generally shortened and arranged in two districts divided at latitude 35°. In California the dove season was made later and in Minnesota shortened 20 days; in Oklahoma the quail season was curtailed six weeks, and in Michigan, Nevada (ducks), Tennessee, and Wyoming, spring shooting of waterfowl was abolished.

EXPORT AND SALE.

Three important changes have radically affected traffic in game in the Mississippi Valley during the present year. In February the Supreme Court of Arkansas¹ held that a local law permitting shipment of game from the Chickasawba district of Mississippi County, Ark., was unconstitutional, and that the general law prohibiting shipment of game was in effect in this county as well as in other parts of the State. A little later the Legislature of Tennessee prohibited the sale of all protected game taken within the State, thereby cutting off the market for ducks killed on Reelfoot Lake. Finally, in June, a new game law was passed in Illinois prohibiting sale of all game, native or imported, except rabbits. For 20 years or more Illinois has permitted the sale at certain seasons of game imported from other States. Illinois now not only prohibits the sale but also the export of all protected game except rabbits. Missouri has strengthened its export law by a provision prohibiting export of quail for any purpose.

¹ Jonesboro Lake City & Eastern R.R. Co. v. Adams, 174 S. W. 527.

BAG LIMITS.

A bag-limit law was passed for the first time in Arkansas—applicable to deer, bear, turkey, quail, and ducks. Limits were established in Connecticut on squirrels and waterfowl; in New Hampshire on quail, ruffed grouse, and woodcock; and in Pennsylvania on bear. Indiana opened the season on prairie chickens for the first time in several years, and provided a limit of five birds per day.

Reductions in limits were made on deer in Alaska from 6 to 3, in Montana from 3 to 2, and in Michigan and Nevada from 2 to 1. In the case of birds the more important reductions in daily bag limits were made in Illinois on doves from 15 to 10; in Iowa on quail from 25 to 15, and on prairie chickens from 25 to 8; in Minnesota on all birds except ducks, from 15 to 10; in Oklahoma on quail, plover, snipe, and ducks, from 25 to 10. Only a few increases were provided: In Illinois on shore birds, in Missouri on birds (except turkeys) from 10 to 15, and in Nevada on quail from 15 to 20.

LICENSES.

Resident licenses were provided for the first time in three Southern States—Arkansas, South Carolina, and Tennessee. Arkansas established a \$1 license for deer and a \$1 license for dogs used in hunting quail; South Carolina a license of \$1 for hunting in the county and \$3 in the State, but 27 counties were exempt from the operation of the act; and Tennessee a \$1 license for the county and \$2 for the State. New Mexico and Vermont joined the list of States which now issue combined hunting and fishing licenses.¹ Delaware, following the example of West Virginia in 1913, repealed the resident license provision adopted two years ago, while West Virginia restored the license by issuing free licenses to persons hunting in the county of residence and requiring a fee of \$3 to hunt elsewhere in the State. Fees for nonresident licenses were reduced in Illinois from \$15 to \$10, in Maine from \$25 to \$15, and for the special elk resident license in Wyoming from \$15 to \$10. New Hampshire and South Carolina, on the other hand, increased the nonresident fee in each case from \$10 to \$15, and Manitoba the resident big game license from \$2 to \$4. Exemptions were provided in a few cases—notably in Illinois, which allows veterans of the Civil War to hunt without a license, and in Oregon, which issues free licenses to veterans. In the latter State women are now allowed to hunt and fish without license, but in New Mexico similar privileges are not granted. North Dakota allowed actual settlers to obtain a resident license, even though they have not acquired residence. In Michigan and Minnesota all residents are now required to obtain licenses to hunt in the county of residence. In North Dakota and Vermont conviction of violating

¹ For list of States which require licenses for hook and line fishing, see footnote, p. 55.

the game laws not only results in forfeiture of license, but renders the holder ineligible to obtain another for a year, except with the consent of the game commissioner in Vermont.

WARDEN SERVICE.

About one-third of the States have made important changes in the administration of warden service. Arkansas established a State game and fish commission of four members, while Florida abolished the office of State game and fish commissioner and intrusted the work of enforcement to county wardens. The total number of States which have general officers in charge of game-law enforcement remains the same as last year, and four States—Florida, Mississippi, Nevada, and Virginia—still rely on local officers. Reorganization of commissions resulted in Minnesota and New York in the substitution of a single officer in place of a commission; in Michigan in the combination of the game, fish, and forest department with the public-domain commission; and in Wisconsin in the consolidation of the work of the game-warden department with that of several other State offices under a new conservation commission. In Illinois the title of the commission was changed from conservation commission to game and fish commission; in North Dakota to game and fish board; and in Ohio from an agricultural commission to a board of agriculture—the latter without salary. In Oregon the board was reorganized with the governor as chairman, and two members from west of the Cascades and two from the eastern part of the State. The position of warden in Tennessee was placed on a salary basis of \$2,500 per annum, the salary of the secretary of the Pennsylvania commission was made \$3,000, the salary of the secretary of the North Dakota game board \$1,200, and the salary of the State warden of New Mexico was increased from \$1,800 to \$2,000. Apparently the only important decrease was in the compensation of the conservation commissioner of New York from \$10,000 to \$8,000.

Increases in the number of wardens were authorized in several States. In Illinois the addition included 1 district warden and 18 deputies; in New Hampshire, 10 wardens; in New Jersey, an assistant fish and game protector; in North Dakota, a State game and fish commissioner; in Pennsylvania, 20 protectors; in South Dakota, 1 additional assistant in the office and 1 in charge of the game farm; in Washington, 4 special deputy wardens; and in Wyoming, 3 additional assistants.

GAME REFUGES AND PRESERVES.

Two national bird reservations have recently been created by Executive order—Mille Lacs, a small island in the lake of the same name in Mille Lacs County, Minn. (May 14, 1915), and Big Lake, in

Mississippi County, Ark. (Aug. 2, 1915). The Blackbeard Island reservation in Georgia, created in 1914, was abandoned as a national bird reservation.

Legislation affecting refuges was enacted in at least 14 States, and included not only provision for new refuges, but changes in boundaries and elimination of several of those already created. In California two refuges were created in the Angeles National Forest in Los Angeles and San Bernardino Counties, and one in the Trinity National Forest in Trinity County. Idaho established the Lewiston Orchards preserve in Nez Perce County and the Black Lake game refuge in Adams and Idaho Counties (which was stocked with 50 elk from the Yellowstone National Park), and renewed protection for five years on big game and game birds in seven counties in the southeastern corner of the State. Montana enlarged the Snow Creek game preserve and decreased the area of the Gallatin preserve. Oregon abolished the Capitol, Imnaha, and Steens Mountain preserves created two years ago. Wyoming created the Hoodoo Basin preserve in Park County, eliminated a strip 4 miles wide along the eastern boundary of the Big Horn preserve, changed the boundaries of the Popo Agie and Teton preserves, and abolished the Laramie preserve, the boundaries of which were not clearly defined in the act creating it.

Provision for the creation of State refuges on private lands was made in several States. Illinois, Pennsylvania, and West Virginia authorized the commission to enter into contract for the establishment of such refuges. Minnesota limited the minimum area of refuges on private lands to 640 acres, Washington required written consent of the landowners, and West Virginia limited the area in any one county to 10,000 acres. Tennessee provided for a propagating farm on lands set aside for the purpose and prohibited hunting on State lands, including Brushy Mountain and Herbert Domain.

NEW LAWS PASSED IN 1915.

Alaska.—By regulation: Reducing the limit on deer from six to three, and prohibiting the sale of deer carcasses in southern Alaska until August 1, 1916.

Alabama.—Two acts: Protecting elk for 10 years and permitting importation of elk for propagation (No. 100); conferring concurrent jurisdiction with circuit courts on justices of the peace and judges of inferior courts in cases relating to birds, game, or fish (No. 104).

Arizona.—No legislation.

Arkansas.—One act, general: Establishing State game and fish commission of five members, warden service, and a game-protection fund; prescribing resident deer license, and \$1 tax on dogs used for hunting quail; fixing limits on deer, bear, turkeys, quail, and ducks, and establishing a season on bear; shortening the season three months on deer, two months on quail, and six months on turkeys, but providing a special open season of six weeks on turkey gobblers in spring (act 124).

California.—Thirteen acts: Redistricting the State into 30 fish and game districts (S. B. 681); prohibiting the killing of game in certain districts; making seasons for

waterfowl conform to Federal migratory bird law; shortening the season for taking quail and rabbits and making it uniform; shortening seasons on deer; shifting the season and providing a uniform law throughout the State on doves; reducing bag limits; defining predatory animals; providing for disposition of fines and forfeiture in game and fish cases; regulating the sale and distribution of hunting licenses; defining and enlarging the duties of the commission (S. B. 1268); prohibiting the use of an animal blind or an imitation thereof in hunting wild birds and allowing sale of deer hides under a tagging system.

Colorado.—Two acts: Repealing sections 2643-2645, Revised Statutes, 1908, now obsolete, which combined forestry, game and fish protection under one department (ch. 90); protecting rabbits and hares, except jack rabbits, from March 1 to October 1 (ch. 93).

Connecticut.—Thirteen acts: Establishing limits on gray squirrels, 6 a day, 30 a season (ch. 25); lengthening the season on waterfowl two weeks; prohibiting the taking of waterfowl between sunset and sunrise, thus harmonizing State and Federal laws; establishing a daily limit of 25 on waterfowl, and permitting the possession and sale of domestically reared waterfowl at any time (ch. 39); prohibiting hunting in Westport fire district (ch. 97); on State game preserves or highways adjacent thereto (chs. 94, 131); fixing a limit on pheasants, Hungarian partridges, and woodcock of 5 a day and a yearly limit of 36 for each species (ch. 122); allowing the importation of game lawfully killed outside the State under permit, if not for sale (ch. 136); authorizing nonresident licensee, under permit, to take out of the State, in his possession, game lawfully killed and duly tagged, if not for sale (ch. 146); providing a limit on hares and rabbits, except Belgian and German hares, of 5 a day and a yearly limit of 35 (ch. 167); empowering the governor to close season in time of drought for prevention of forest fires (ch. 218); requiring hunting license to trap fur-bearing animals (ch. 240); permitting sale and transportation at any time of deer, pheasants, and waterfowl raised in licensed preserve (fee \$2) when properly tagged (ch. 276); permitting landowner or lessee of agricultural lands to kill deer on own lands by means of a shotgun at any time, provided such killing is reported within 24 hours to the commissioners of fisheries and game (ch. 308).

Delaware.—Six acts: Requiring board of game and fish commissioners to turn over to State treasurer for credit to game fund all moneys received from sale of licenses and from fines imposed (ch. 193); shifting the season on squirrels to open September 1 instead of November 15 (ch. 194); permitting sale of imported rabbits during open season when labeled as "Shipped rabbits" (ch. 195); repealing the resident-license law (ch. 196); removing protection from turkey buzzards (ch. 197); concurrent resolution opposing Federal protection of migratory birds (ch. 252).

Florida.—One act (amending game law generally): Abolishing office of State game and fish commissioner and authorizing county commissioners to appoint county wardens to hold office until 1917, their successors to be chosen at primary elections, salary, \$100 to \$600 per annum; declaring that the ownership and title to all wild birds and game in the State shall be vested in the respective counties for the purpose of regulation and use; lengthening the season two months on squirrels and three weeks on deer and game birds; prescribing licenses, resident of county \$1, nonresident of county but resident of State \$3, nonresident of State \$15.

Georgia.—No legislation.

Idaho.—Eight acts: Creating the Black Lake game preserve in Adams and Idaho Counties (ch. 9); protecting quail in Lemhi County for four years (ch. 33); closing season for five years on big game, quail, and Mongolian pheasants in Bannock, Bear Lake, Cassia, Franklin, Oneida, Power, and Twinfalls Counties (ch. 72); prohibiting hunting of mountain sheep and of females (and young under 1 year of age) of deer and elk (ch. 90); closing the State to elk hunting except for male elk in Fremont, Bonne-

ville, Teton, and Bingham Counties (ch. 96); requiring written consent to hunt on inclosed and posted lands (ch. 152); establishing the Lewiston Orchards game preserve in Nez Perce County (ch. 155); petitioning Congress to create the Sawtooth National Park.

Illinois.—One act (amending game law generally): Changing title of commission from State game and fish conservation commission to State game and fish commission; providing a permanent warden service of 7 wardens and 78 deputies in lieu of 6 wardens, 60 deputies, and 60 deputies for temporary service; shifting the season on prairie chickens to open October 1 instead of November 1; lengthening the season on squirrels $2\frac{1}{2}$ months by opening August 1 and closing February 1; protecting rail, swan, and the smaller shore birds until 1920, and harmonizing State and Federal seasons on migratory birds, except on coot and waterfowl; providing an open season on coot and waterfowl in spring from February 15 to April 1; prohibiting shooting from power boats on the Mississippi River; opening season on cock pheasants from October 1 to 6 and providing a limit of two a day; protecting rabbits from February 1 to August 31; prohibiting the sale of all protected native and imported game except rabbits; removing protection from cormorants; defining pigeons as game birds; reducing the limit on doves from 15 a day to 10; increasing the limit from 15 shore birds a day to 15 each of plover, jacksnipe, and yellow-legs; limiting the amount of game that may be had in possession; prohibiting the export of all protected game except rabbits; forbidding the importation of game except deer lawfully killed and shipped; authorizing commission to grant permits for scientific collecting, and increasing the fee from \$1 to \$5; reducing the fee for nonresident license from \$25 to \$10; empowering the commission to establish refuges by contract on private lands and to have planted suitable grain for bird and game food not to exceed 5 acres on each 1,000-acre reservation; permitting game bred in captivity under license to be sold for propagation and scientific purposes (S. B. 439).

Indiana.—Four acts: Permitting honorably discharged veterans of Civil War to hunt without license (ch. 44); providing that birds and mammals bred and reared in captivity may be disposed of by owner or propagator without reference to the game laws (ch. 46); prohibiting use of search or other artificial lights attached to automobiles for hunting game on highways or within 150 yards thereof, and forbidding shooting upon, along, or across any public highway (ch. 54); opening the season from October 15 to November 1 on prairie chickens, limit 5 a day; and affording protection throughout the year to Hungarian partridges and imported pheasants (ch. 124).

Iowa.— — acts: Providing special limits—on quail, 15 a day, 25 in possession; on prairie chicken, 8 a day, 16 in possession; requiring resident aliens to obtain non-resident licenses to hunt; extending term protection on pheasants and Hungarian partridges until 1917; permitting propagation of game birds for sale under \$2 license.

Kansas.—Three acts: Limiting the expenses of the fish and game hatchery to \$18,000 a year and providing that surplus moneys from sale of licenses shall be credited to a special State game preserve fund to be held until appropriated by the legislature; authorizing the governor to appoint one or more deputies in each county when deemed advisable; and repealing the provision requiring a request from 10 resident taxpayers for the appointment of a county warden (ch. 11); abolishing the fee allowed county clerks for issuing resident licenses (ch. 227); fixing special penalty for hunting on lands of another without written consent; and providing that prosecutions shall be maintained only on complaint of the landowner (ch. 248).

Maine.—Twelve acts: Prohibiting hunting on Kineo Point, Piscataquis County (ch. 75); prohibiting hunting for five years on southerly point of Swan Island, town of Perkins (ch. 93); closing the season on bull moose until 1919 (ch. 146); protecting waterfowl on certain portions of Back Bay, Cumberland County (ch. 153); shortening the season one month on rabbits (ch. 154); forbidding night hunting of birds from sunset to sunrise and mammals from one hour after sunset to one hour before sunrise (ch. 170); reducing the general nonresident license fee from \$25 to \$15 and the export

limit under nonresident license on partridge from 10 to 5 and on ducks from 15 to 10 (ch. 230); strengthening the law for the registration of guides (ch. 234); shortening the season two weeks on ruffed grouse; harmonizing seasons under State and Federal laws on migratory species; protecting the smaller shore birds at all seasons; and prohibiting more than daily limit on ducks to be transported (ch. 258); fixing salary of clerk of commission of inland fisheries and game (ch. 269); shortening the season one month on gray squirrels; broadening the law prohibiting hunting on Sunday, clarifying the alien license law, and extending the sale season two weeks during which licensed residents may sell deer hides and trophies (ch. 277); prohibiting the use of boats other than sail or row boats in hunting wild fowl in certain coastal waters of the State (ch. 345).

Massachusetts.—Three acts: Prescribing a special penalty of \$20 for killing quail in Essex County prior to 1919 (ch. 3); granting State auditor power to demand license record books of city and town clerks for purpose of auditing, and prescribing a penalty of \$50 for neglect or refusal (ch. 212); prohibiting resident aliens from hunting or owning or possessing shotgun or rifle, but exempting those who own real estate to the value of \$500 (ch. 240).

Michigan.— acts: Placing administration of the game laws under the public domain commission as the game, fish, and forest-fire department; requiring residents to obtain licenses to hunt in county of residence; exempting persons under 17 from license requirements; forbidding use of automobiles or power boats for hunting partridge and waterfowl; reducing the limit on deer from two to one; requiring deer to be tagged with metal self-locking seal immediately after being killed; prohibiting the possession of headlights; allowing deer to be possessed for 30 days after close of season; shortening the season one month on rabbits and making the opening date uniform with that prescribed for ruffed grouse; continuing term protection on squirrels, quail, imported pheasants, Canada grouse, prairie chickens, and wild turkeys until 1920; harmonizing State and Federal laws on migratory game birds, thus abolishing spring shooting, and protecting the smaller shore birds until 1920; prohibiting night shooting of waterfowl from one-half hour after sunset to sunrise.

Minnesota.—Six acts: Prohibiting shooting aquatic fowl from boat beyond natural vegetation growing above the water, or within such natural covering in any boat or craft propelled otherwise than by hand; forbidding the use of rifles in killing geese and brant, and repealing provision prohibiting shooting from one hour after sunset to one hour before sunrise (ch. 181); protecting doves, woodcock, upland and golden plover, and wood duck until 1918; reducing the limit on birds, except ducks, from 15 to 10 a day, the limit allowed in possession at one time on ducks from 50 to 45, and on other birds from 45 to 30 (ch. 237); requiring residents over 21 years of age, except those hunting on own land, to obtain a license to hunt game birds in their own county; requiring all residents to obtain license for big game (ch. 287); providing for the establishment of game refuges of not less than 640 acres of contiguous lands on private holdings, and authorizing commissioner to close season on game when deemed advisable (ch. 288); prohibiting possession of game birds after December 31 and of deer and moose after January 31 (ch. 351); abolishing State game and fish commission and executive agent and creating office of State game and fish commissioner, term two years, salary \$2,500 per annum (ch. 355).

Missouri.—Four acts: Permitting the parole of game-law violators imprisoned for failure to pay fines (p. 287); prohibiting the shipment of quail from State for any purpose (p. 288); providing that county clerks shall not be required to account for clerk fees allowed them for the issuance of hunting licenses (p. 289); lengthening season on squirrels 2 months and on quail 20 days; shortening season 20 days on doves; providing a State open season from November 10 to January 1 on woodcock; prohibiting use of motor boats on Missouri and Mississippi Rivers for aquatic birds; fixing a limit of 10 quail a day, 15 in possession, and increasing the bag on other birds

(except wild turkeys) from 10 a day to 15 and the limit in possession from 15 to 25; allowing eating establishments to store and serve deer and elk raised in captivity; defining a conspiracy to violate the game and fish laws and prescribing penalties from \$50 to \$500; permitting deer and elk to be raised in captivity under \$5 licenses; prohibiting the transportation of game except by holder of resident or nonresident license (p. 290).

Montana.—Nine acts: Prohibiting hunting on posted lands without consent of owner (ch. 36); lengthening season on elk 2 weeks by closing December 15 (ch. 75); opening season on elk in Stillwater County, and protecting sheep and goats until October 1, 1918 (ch. 76); lengthening season on deer 2 weeks by closing December 15; reducing yearly limit on deer from 3 to 2, but permitting killing of fawns and removing the restriction to 1 doe in a season's limit; shifting season on grouse, prairie chicken, fool hen, sage hen, pheasant, and partridge to open in part of State September 1 (balance Sept. 15) instead of October 1; prohibiting killing of swans (ch. 98); making license collectors liable for licenses at their face value (ch. 107); prohibiting the use of silencers on guns while hunting (ch. 108); enlarging the Snow Creek game preserve (ch. 121) and decreasing the limits of the Gallatin preserve (ch. 124); authorizing a cost bill, payable from game-protection fund, to reimburse counties for expenses incurred in enforcing fish and game laws (ch. 138).

Nebraska.—No legislation.

Nevada.—Four acts: Repealing provision withholding compensation of school teachers for failure to give oral instruction once a month relative to the preservation of song birds, fish, and game (p. 18); removing swan from the game list; protecting pheasants until 1920; lengthening open season on sage hens $4\frac{1}{2}$ months, on grouse 1 month, and on quail 2 weeks; abolishing spring shooting of ducks and shore birds by closing January 1; providing an open season on prairie chickens from September 15 to January 2; prohibiting use of shotguns larger than No. 10 gauge; opening the deer season September 15 instead of October 15, reducing limit from 2 to 1 a season, and removing protection from does; permitting 1 antelope to be taken during the deer season; prohibiting hounding of big game; increasing limit on mountain and valley quail from 15 a day to 20 each; authorizing collection of birds, their nests and eggs for scientific purposes under written permit from the governor (p. 432); making the appointment of a fish and game warden discretionary with the several boards of county commissioners instead of mandatory (p. 395); permitting killing, selling, and shipping under invoice of game raised in licensed preserves (p. 363).

New Hampshire.—Three acts: Shortening the season during which hunting dogs may run at large (ch. 14); revising and amending the game laws; prohibiting hunting from sunset to sunrise; permitting unrestricted export of game (except ruffed grouse) imported from without the United States or raised in private preserves when duly marked and tagged; prohibiting sale of dead bodies of birds belonging to a family any species or subspecies of which is native to the State; adding starlings and owls to the list of unprotected birds; shortening the season one month on hares and rabbits and prescribing a limit of five a day; protecting gray squirrels until 1919; harmonizing seasons on migratory game birds under State and Federal laws; establishing limits, on quail, 5 a day, ruffed grouse and woodcock, 10 a day, each 50 a season, and ducks, 20 a day; increasing the nonresident license fee from \$10 to \$15; prohibiting the issuance of a license to minors under the age of 13, but permitting them to hunt when accompanied by licensed parent or guardian; authorizing the appointment of 10 fish and game wardens and necessary deputies (ch. 133); authorizing governor and council to transfer sufficient funds from the fish and game receipts for 1914 to meet deficiency of the commissioner's office from May 1 to September 1, 1915 (ch. 134).

New Jersey.—Ten acts: Permitting sale of wild waterfowl, reedbirds, and rail during open season and 15 days thereafter (ch. 64); increasing number of assistant fish and game protectors from one to two (ch. 71); protecting wood duck for three years

(ch. 193); lengthening season on waterfowl and making it uniform on all species (ch. 194); defining training season for bird dogs (ch. 217); requiring shipments of game to be open to view (ch. 219); changing season on deer from the first five days in November to the last three Wednesdays in October and the first Wednesday in November and removing protection from does; protecting fawns under 1 year of age (ch. 247); permitting sale of rabbits and hares on proof that they were not trapped in New Jersey (ch. 252); permitting game commission to issue licenses to citizens of the United States between the ages of 10 and 14 upon application of parent or legal guardian and payment of a fee of \$1, provided they hunt in company with a licensed adult (ch. 320); making it unlawful for an unnaturalized, foreign-born person to hunt or to own a shotgun or rifle unless he is the owner of real property in the State to the value of \$2,000 above all encumbrances (ch. 355).

New Mexico.—One act (amending the game law generally): Increasing salary of State game warden from \$1,800 to \$2,000 per annum; removing from the game list antelope, buffalo, Sonoran deer, pheasants, bob-white quail, wild pigeons, and swans; prohibiting sale of Sonoran deer, buffalo, tassel-eared gray squirrels, grouse, prairie chickens, sage hens, and native and bob-white quail; prohibiting transportation of game unless accompanied by shipping permit; requiring women to obtain licenses; districting the State north and south of latitude 35°; shortening season 25 days on deer north of latitude 35°, and 15 days south, by opening October 25 and closing November 26; on wild turkeys north of latitude 35°, 15 days; south, one month; on grouse, 5 days; on quail, 25 days; on doves, 6 weeks, by opening August 16; extending term protection on prairie chickens and sage hens for 5 years; reducing daily limit on wild turkeys from 4 to 3, on grouse from 6 to 5, and on quail and doves from 30 to 20 each; prohibiting killing of migratory birds from sunset to sunrise; forbidding use of dogs in hunting big game; authorizing appointment of one office clerk at \$900 and increasing salary of chief deputy from \$900 to \$1,200 per annum; creating a combination hunting and fishing license, and increasing license fees (H. B. 202).

New York.—Act substituting a single commissioner at a salary of \$8,000 for a commission of 3 members at \$10,000 each.

North Carolina.—Three general acts: Removing protection from turkey buzzards (ch. 182); authorizing Federal Government to make regulations for protection of game on lands purchased for the protection of watersheds and navigable streams (ch. 205); authorizing acceptance of gifts of land to demonstrate practical utility of timber culture, water conservation, and game refuges (ch. 253). Fifty-eight local laws.¹

North Dakota.—Two acts: Redistricting the State according to judicial districts; fixing salary of secretary at \$1,200 and expenses; authorizing creation of game farms and refuges, and capture of birds or animals for propagation, or exchange with other States; authorizing appointment of State game and fish commissioner and deputy commissioner at \$1,500 a year each in charge of fish hatcheries and game propagation and distribution; abolishing office of county game warden and authorizing appointment of one or more special State-wide deputies in each county, to serve without compensation; prohibiting shooting from boats in open water and allowing boats to be concealed in natural blinds only; prohibiting shooting from sunset to sunrise and protecting cranes and swans to September 7, 1918; forbidding use of dogs for hunting moose and elk, and lengthening training season two weeks on bird dogs; prescribing special \$1 resident license for deer hunting after 1920; reducing export limit under nonresident license to 20 grouse and 30 waterfowl; providing that resident licenses may be issued to actual settlers and that a violator shall forfeit his license and the hunting privilege for the season in addition to fine imposed; removing protection from cormorants; reducing limit on plover from 25 a day to 10; on waterfowl and shore birds from 25 a day to 15; and establishing a limit of 15 a day on rails; affording

¹ The proposed amendment of the constitution passed at the extra session of 1913 (ch. 81) to prohibit the enactment of local game laws was defeated at the general election, November 4, 1914.

protection all the year to elk, moose, and antelope; authorizing creation of State game refuges on private lands, and breeding and resting places for waterfowl on lands adjoining lakes; prohibiting hunting in Sully's Hill National Game Preserve and in other National or State game refuges hereafter created; prohibiting impersonation of game wardens; providing that no criminal action may be started against a game warden for false arrest without the approval of the State's attorney; forbidding any person who is not a citizen of the United States or who has not declared his intention to become such, to hunt or to own or be possessed of a shotgun or rifle (ch. 161); protecting deer until November 10, 1920 (ch. 162).

Ohio.—One act: Removing doves from the game list for two years and continuing protection for two years on quail, ruffed grouse, Hungarian or gray partridge, and introduced pheasants, and providing a special open season on waterfowl in spring during the month of March (H. B. 24).

Oklahoma.—Three acts: Providing that 25 per cent of license receipts shall be turned into the State game protection fund, balance to go to the county road and bridge fund; shortening the quail season six weeks; giving protection all the year to prairie chickens, doves, cranes, wood ducks, long-billed curlews, pelicans, gulls, and herons; reducing limit on wild turkeys from 3 to 1, but permitting 1 gobble to be taken between March 15 and April 15; on quail, plover, snipe, and ducks from 25 a day to 10, and from 150 to 100 a season; permitting game to be raised in captivity under license (fee, \$2) and to be sold and transported at any time for propagation and for food during such seasons as the warden may prescribe, when properly marked and tagged (S. B. 333); appropriating \$30,000 for propagation and distribution of game and fish, and \$40,000 for maintaining the department for next two years (S. B. 334); prohibiting hunting of deer, bear, and wild turkey in Blaine, Caddo, Comanche, Kiowa, and Major Counties, for the protection of game escaping from Wichita national game preserve (H. B. 569).

Oregon.—Ten acts: Authorizing the granting of free licenses to veterans of Civil War (ch. 21); repealing provisions permitting killing of free-running dogs and holding owner liable for dogs chasing deer without his aid or direction (ch. 37); permitting women to hunt and fish without a license (ch. 57); providing that all fines collected for violations of game and fish laws shall go to the general fund of the county in which imposed (formerly half the fines went to the State game protection fund) (ch. 77); prohibiting use of certain boats for hunting or disturbing waterfowl on Netarts Bay (ch. 100); defining the word "protection" as used in the game law to include educational, scientific, and other work which may be effective in the conservation of wild life (ch. 181); reorganizing the State board of fish and game commissioners, providing that the governor shall be chairman ex officio, and authorizing the appointment of four members; authorizing appointment of State game warden and fixing his salary at \$2,400 per annum, and such deputy game and fish wardens, at \$3 a day and actual expenses when employed, as may be necessary for enforcing the law; permitting boys under 14 to hunt without a license; providing that 5 per cent of license receipts collected in any county shall be turned into the general fund of the county (ch. 287); authorizing State game warden to compile and annotate the game laws (H. C. Res. No. 16); abolishing the Imnaha, Steen's Mountain (ch. 103), and the Capitol game preserves (ch. 347); shortening season two weeks on deer by opening August 15; closing season on quail except in Coos, Curry, Jackson, and Josephine Counties; permitting ducks to be taken in Coos County during January; lengthening season two weeks on rails, coots, shore birds, and waterfowl, and one month on geese in seven counties in northern part of State; providing an open season covering the first 15 days in October on prairie chickens in Sherman, Union, and Wasco Counties; lengthening season two weeks on sage hens and grouse; permitting geese taken in Crook, Gilliam, Harney, Morrow, Sherman, Umatilla, and Wasco Counties to be sold during open season, when duly tagged by a game warden (ch. 331).

Pennsylvania.—Ten acts: Authorizing game commissioners on petition of 200 citizens to close season for five years on certain game when deemed necessary (No. 42); authorizing payment of bounties on certain wild animals from fund consisting of 50 per cent of license receipts (No. 60); authorizing game commissioners to direct the killing of blackbirds if they become a nuisance in any locality (No. 61); lengthening season six weeks during which dogs may be trained on game birds (No. 63); authorizing creation of preserves on private lands by contract (No. 65); shifting the deer season from November to first 15 days in December; shortening the season on bear, hares, and rabbits one month, and making the season on squirrels and upland game birds uniform by opening October 15; providing a six weeks' open season on wild turkeys and blackbirds; prohibiting sale of squirrels, rabbits or hares, ring-necked pheasants, and Hungarian partridges taken in State; permitting sale at any time of deer, elk, Belgian or German hares, and ring-necked pheasants reared in captivity, when properly marked and tagged; prescribing a limit of one bear a season; fixing weekly and yearly limits on squirrels and rabbits and daily, weekly, and yearly limits on hares and ring-necked pheasants; reducing limits on quail, ruffed grouse, and Hungarian partridges; defining a week as beginning Monday morning and ending Saturday night; and prohibiting shipment of game by parcel post (ch. 73); authorizing foresters and forest rangers, game protectors and deputy game protectors, and fish wardens and deputy fish wardens to enforce the forest, fish, and game laws, but providing that prosecutions shall be brought under the direction of the respective branches of forestry, fisheries, and game protection (No. 77); increasing the warden service from 30 to 50 game protectors (No. 91); appropriating \$303,200 from license receipts for game protection (No. 230); prohibiting aliens from possessing dogs or hunting with them (No. 644).

Rhode Island.—Two acts: Protecting wild birds and game on public lands and prohibiting hunting except under written license and regulations of officials in charge of said lands (ch. 1229); lengthening season on waterfowl six weeks by closing February 16; prohibiting shooting of migratory birds between one hour after sunset and one hour before sunrise (ch. 1255).

South Carolina.—Seven acts: Opening the season on deer and wild turkey in Bamberg County (No. 58); lengthening season one month on deer in Barnwell County (No. 79); providing a close season on squirrels in Chesterfield and York Counties (No. 121); increasing nonresident license fee from \$10.25 to \$15.25 (No. 141); lengthening season one month on deer in Florence and Marion Counties (No. 147); prescribing license for resident hunters, fees, county license \$1.10, State license \$3, permitting hunting on own land by owners, tenants, and members of family and by residents of county under written permission of landowner, but exempting 27 counties from operation of act (No. 151); reducing the open season on quail and wild turkeys in Abbeville, Chester, and Lancaster Counties to two months (No. 349).

South Dakota.—Six acts: Allowing under license or permit the shipment of hide, trophy, or carcass of lawfully killed deer (ch. 201); making it unlawful to maintain a salt lick or to use any screen, blind, elevated scaffold, or other device for killing deer at salt licks (ch. 202); providing that warrants for salaries of county wardens unpaid for want of funds in county may be paid from State game fund (ch. 203); prohibiting the carrying of firearms on State game preserve (ch. 204); authorizing payment of a reward of \$50 from game-protection fund for conviction of person violating game laws in regard to big game (ch. 206); increasing the warden service from 3 to 5 assistants by adding an office deputy and a gamekeeper at the State game park, and making Federal and State foresters ex officio deputy State wardens (ch. 207).

Tennessee.—One act (amending the game law generally): Changing the department of game, fish, and forestry to the department of game and fish and authorizing appointment of State warden, term two years, at a salary of \$2,500 per annum; per-

mitting deputy game and fish wardens to be appointed in each county, compensation \$1 a day under special instructions from State warden; prescribing \$1 county and \$2 State license for residents in lieu of a \$3 optional license; creating a game and fish protection fund; declaring ring-necked pheasants, bullbats, robins, meadowlarks, and marsh blackbirds to be nongame birds; empowering warden to establish a State propagating farm on lands donated to the State or State lands set aside by the governor for said purpose; prohibiting hunting on certain public lands, including tracts of Brushy Mountain and Herbert Domain and grounds of certain State institutions; protecting deer until 1917; establishing a State season from June 1 to January 1 on squirrels; shortening seasons, 2 months on quail, 3 months on doves, 2½ months on wild turkeys, but permitting gobblers to be taken during first 25 days of April, and harmonizing State and Federal laws on migratory game birds, thus abolishing spring shooting; extending the provision prohibiting shooting of waterfowl from sunset to sunrise to include all birds; reducing the limit on birds from 50 ducks and 30 other birds to 20 a day; prohibiting sale of all protected game taken in State (ch. 152; — local acts).

Texas.—Two acts: Prohibiting the use of mechanical or natural devices for attracting the attention of deer (ch. 107); lengthening the dove season three months by opening September 1 and closing March 1; shortening the quail season one month by opening December 1 (ch. 123).

Utah.—One act: Shifting the deer season to open October 15 instead of October 1, protecting does and fawns, and permitting only deer with horns visible above the head to be killed; shortening the season two months on sage hens; affording an open season of two weeks on doves, beginning August 15; providing a tagging system under which game raised by residents in licensed preserves (fee \$25) may be sold; permitting preserve owners to capture a limited amount of game for propagation; providing that 25 per cent (one pair in four) of game reared in captivity shall be liberated under direction of commissioner or deputy; prescribing a daily limit of 15 doves and 8 other upland game birds (except quail) combined (ch. 118).

Vermont.—Six acts: Changing the open season on deer (No. 176); changing the woodcock season to conform with the Federal regulations (No. 177); prescribing a combination hunting and fishing license (fee, resident \$1, nonresident \$10.50), and resident hunting license, fee 60 cents; regulating transportation of game; making it a misdemeanor knowingly to guide a hunter or angler who has not been duly licensed; abolishing annual appropriation of \$5,500 for maintenance of State fish hatchery and protection and preservation of fish and game (No. 182); changing the open season on wild fowl (No. 186, No. 187); and providing for expenses of the State game commissioner (No. 229).

Washington.—One act (amending game law generally): Requiring consent of landowners for county game commission to close restocked areas; reducing the zone limit along the Columbia and Snake Rivers from one-half to one-quarter mile in which waterfowl are protected, and extending the protected area through Benton and Grant Counties; repealing the authority of incorporated societies of natural history to issue permits for scientific collecting, requiring applications for such permits to be approved by the University or State College of Washington, and prohibiting sale of specimens collected; authorizing county game commissioners to create preserves on private lands only with the written consent of owners; authorizing appointment of four special deputy wardens at \$3 a day and traveling expenses, payable from State game fund, for assignment by chief game warden and chief deputy game warden; protecting game squirrels at all times; shortening season on deer and goats two weeks, and affording absolute protection to mountain sheep; providing an open season of six weeks on caribou east of Cascades; shortening the upland bird season 15 days; conforming State and Federal seasons on migratory birds, protecting smaller shore birds and prohibiting hunting from sunset to sunrise; prescribing a weekly limit of 20 on waterfowl and

shore birds and prohibiting possession of more than 30 waterfowl at a time; defining a week to begin at midnight Saturday night; permitting residents to bring into the State big game if accompanied by affidavit of lawful killing and shipping receipt from originating point, if not for sale or profit; providing that 20 per cent of the moneys received for State hunting and game-fish licenses shall go to the county game fund of county in which collected; appropriating \$12,000 from State game fund for payment of salaries and expenses of special deputies and fisheries inspectors (ch. 151). (Governor vetoed three sections.)

West Virginia.—Two acts: Making it unlawful for aliens to hunt or to possess firearms of any kind for such purpose, prescribing licenses for hunting, nonresident, fee \$16, resident, State, fee \$3, county, no fee, and providing that licensee shall wear a tag bearing license number; defining elk and rabbits as game; protecting elk for a term of 8 years, but permitting those in captivity or that have escaped from captivity to be killed at any time by the owner; and making it a felony to hunt or chase deer with dogs or to violate the law in regard to elk; harmonizing State and Federal seasons on migratory game birds, thus prohibiting spring shooting; shortening the season on squirrels two weeks and prohibiting killing of more than 12 a day or 100 a season; fixing an open season on rabbits from October 15 to January 1; providing that 10 per cent of license receipts may be expended for bounties on certain predatory animals and birds; providing for the creation and posting of State game refuges; limiting the area to be set aside as refuges in any one county to 10,000 acres (ch. 14); authorizing warden to purchase, at not to exceed \$5 per acre, lands to demonstrate the practical utility of timber culture and breeding of game (H. B. 177).

Wisconsin.—Fifteen acts: Protecting Hungarian partridges for six years and extending term protection on quail and imported pheasants until 1921 (ch. 32); protecting wood ducks until September 7, 1918 (chs. 55 and 56); protecting aquatic fowl from sunset to sunrise and forbidding hunting on main waters of the Mississippi River at all times (ch. 55); prohibiting the killing of squirrels in Kenosha and Racine Counties until 1921 (ch. 57); protecting rabbits in Manitowoc County, but permitting them to be taken with ferrets on own land in Crawford, Grant, Richland, and Vernon Counties (ch. 85); prohibiting the killing of does and fawns and the possession of carcass or hide from which the evidence of sex has been removed; extending term protection on deer in Wood County until 1921 and affording absolute protection for them in Polk County, but opening the season in Door and Sauk Counties (ch. 102); opening the season on prairie chickens and grouse in Columbia County (ch. 103); requiring owner of shipment of game to give signed statement in presence of receiving agent that he is consignor of said shipment and prohibiting shipment under an alias (ch. 124); modifying seasons on rabbits and squirrels in certain counties and providing limits of 15 a day (ch. 237); prohibiting killing game birds from motor or other vehicles (ch. 246); shifting the season on partridges to open September 7 and extending protection on prairie chickens in certain counties to 1919 (ch. 289); creating the Forest County game refuge (ch. 310); combining the game warden department with several other State offices under the State conservation commission and appropriating \$200,000 for the work of the commission during the next two years (ch. 406); affording protection to prairie chickens in Columbia and Dunn Counties and opening season in Florence and Green Counties (ch. 458); consolidating fish and game laws (ch. 594).

Wyoming.—Two acts (amending game law generally): Authorizing warden or deputies to kill elk doing damage to personal property; increasing number of assistant game wardens from 4 to 7, decreasing compensation of deputy game wardens from \$5 to not less than \$3 nor more than \$4 a day; shortening State season on shore birds 5 months, on ducks and geese 3 months, thus abolishing spring shooting; providing a 9-months' close season on rails, coots, and mudhens; lengthening season two weeks on

grouse (except sage grouse), but shortening season two months in Albany, Carbon, Laramie, and Sweetwater Counties, thus making the season uniform throughout the State; extending term protection on quail and Mongolian pheasants for 4 years; permitting warden to license killing of 50 matured bull moose during season of 1915-16, fee \$100, and requiring licensee to employ deputy warden at \$4 a day to accompany him on hunting expedition; shortening season two weeks on deer in Campbell, Crook, Johnson, Niobrara, Sheridan, and Weston Counties, one month in Fremont, Lincoln, and Park Counties; and lengthening deer season two weeks in balance of State; removing protection from does and fawns; prohibiting certain aliens from owning or possessing firearms or fishing tackle without a special \$25 gun and fish license; removing the restriction to one female elk under resident general license, thus permitting killing of either sex, and decreasing the fee from \$15 to \$10 for a resident special elk license; reducing clerk fees for issuing certain licenses; prescribing a penalty for officer issuing to applicant a license to which he is not entitled; extending term protection on beaver for four years; permitting export and sale of lawfully killed game (except edible portion) when duly tagged, fee 25 cents; decreasing the amount authorized to be expended annually for capture, transportation, and exchange of game for propagation and restocking purposes from \$10,000 to \$4,000 (ch. 91); creating the Hoodoo Basin game preserve; curtailing the limits of the Big Horn game preserve by exempting a strip 4 miles wide on the eastern boundary; abolishing the Laramie game preserve and modifying the boundaries of the Teton and Popo Agie game preserves (ch. 105).

Manitoba.— acts: Increasing the resident big game license fee from \$2 to \$4; protecting curlew until 1920; affording a bag limit of 10 a day on geese; prohibiting the sale of wild ducks before October 8 and then only when they have been killed within 20 miles of the actual residence of the person who killed them, thus practically prohibiting sale by nonresidents; prescribing a \$1 resident bird license, but exempting farmers and members of families actually residing on farm lands in the province; increasing the fee for a cold-storage permit from \$2 to \$5; prohibiting the use of power boats in marshes where waterfowl are found; regulating the placing of blinds and decoys for waterfowl shooting, and requiring decoys to be removed from the water during the hours shooting is prohibited; permitting the issuance of free permits for the export of shed antlers; forbidding the carrying of a loaded shotgun or rifle on a vehicle; prohibiting the killing of game birds (except ducks and geese) and game animals north of latitude 53° except for food for personal use; prohibiting sale of game in general, but permitting sale of wild ducks from October 15 to January 1, if not exported or shipped from said northern section.

New Scotia.—One act: Lengthening the season two weeks on bull moose, and continuing term protection on cow moose and all moose on Cape Breton Island until 1918; shortening the season two months on quail, plover, Wilson snipe, woodcock, other shorebirds, rail, coot, teal, and swan; continuing term protection on deer and caribou until 1918; prescribing an open season on waterfowl from September 15 to March 1, and requiring a \$5 license of aliens who have not resided in the Province for five years (ch. 38).

REGULATIONS FOR THE PROTECTION OF MIGRATORY BIRDS.¹

BY THE PRESIDENT OF THE UNITED STATES OF AMERICA,
A PROCLAMATION.

WHEREAS, an act of Congress approved March fourth, nineteen hundred and thirteen, entitled "An act making appropriations for the Department of Agriculture for the fiscal year ending June thirtieth, nineteen hundred and fourteen" (37 Stat., 847), contains provisions as follows:

All wild geese, wild swans, brant, wild ducks, snipe, plover, woodcock, rail, wild pigeons, and all other migratory game and insectivorous birds which in their northern and southern migrations pass through or do not remain permanently the entire year within the borders of any State or Territory, shall hereafter be deemed to be within the custody and protection of the Government of the United States, and shall not be destroyed or taken contrary to regulations hereinafter provided therefor.

The Department of Agriculture is hereby authorized and directed to adopt suitable regulations to give effect to the previous paragraph by prescribing and fixing closed seasons, having due regard to the zones of temperature, breeding habits, and times and line of migratory flight, thereby enabling the department to select and designate suitable districts for different portions of the country, and it shall be unlawful to shoot or by any device kill or seize and capture migratory birds within the protection of this law during said closed seasons, and any person who shall violate any of the provisions or regulations of this law for the protection of migratory birds shall be guilty of a misdemeanor and shall be fined not more than \$100 or imprisoned not more than 90 days, or both, in the discretion of the court.

The Department of Agriculture, after the preparation of said regulations, shall cause the same to be made public, and shall allow a period of three months in which said regulations may be examined and considered before final adoption, permitting, when deemed proper, public hearings thereon, and after final adoption shall cause the same to be engrossed and submitted to the President of the United States for approval: *Provided, however,* That nothing herein contained shall be deemed to affect or interfere with the local laws of the States and Territories for the protection of non-migratory game or other birds resident and breeding within their borders, nor to prevent the States and Territories from enacting laws and regulations to promote and render efficient the regulations of the Department of Agriculture provided under this statute.

WHEREAS, the Department of Agriculture has duly prepared suitable regulations to give effect to the foregoing provisions of said act and after the preparation of said regulations has caused the same to be made public and has allowed a period of three months in which said regulations might be examined and considered before final adoption and has permitted public hearings thereon;

¹ As amended by the Proclamation of August 31, 1914, modifying Regulation 3, and that of October 1, 1914, modifying Regulation 5, and the waterfowl seasons in Regulations 8 and 9.

And, WHEREAS, the Department of Agriculture has adopted the regulations hereinafter set forth and after final adoption thereof has caused the same to be engrossed and submitted to the President of the United States for approval;

Now, THEREFORE, I, WOODROW WILSON, President of the United States of America, by authority in me vested do hereby proclaim and make known the following regulations for carrying into effect the foregoing provisions of said act:

Regulation 1. Definitions.

For the purposes of these regulations the following shall be considered migratory game birds:

- (a) Anatidæ or waterfowl, including brant, wild ducks, geese, and swans.
- (b) Gruidæ or cranes, including little brown, sandhill, and whooping cranes.
- (c) Rallidæ or rails, including coots, gallinules, and sora and other rails.
- (d) Limicolæ or shore birds, including avocets, curlew, dowitchers, godwits, knots, oyster catchers, phalaropes, plover, sandpipers, snipe, stilts, surf birds, turnstones, willet, woodcock, and yellow legs.
- (e) Columbidae or pigeons, including doves and wild pigeons.

For the purposes of these regulations the following shall be considered migratory insectivorous birds:

- (f) Bobolinks, catbirds, chickadees, cuckoos, flickers, flycatchers, grosbeaks, humming birds, kinglets, martins, meadowlarks, nighthawks or bull bats, nuthatches, orioles, robins, shrikes, swallows, swifts, tanagers, titmice, thrushes, vireos, warblers, waxwings, whippoorwills, woodpeckers, and wrens, and all other perching birds which feed entirely or chiefly on insects.

Regulation 2. Closed Season at Night.

A daily closed season on all migratory game and insectivorous-birds shall extend from sunset to sunrise.

Regulation 3. Closed Season on Insectivorous Birds.

A closed season on migratory insectivorous birds shall continue throughout each year, except that the closed season on reedbirds or ricebirds in New Jersey, Pennsylvania, Delaware, Maryland, the District of Columbia, Virginia, and South Carolina, shall commence November 1 and end August 31, next following, both dates inclusive: *Provided*, That nothing in this or any other of these regulations shall be construed to prevent the issue of permits for collecting birds for scientific purposes in accordance with the laws and regulations in force in the respective States and Territories and the District of Columbia [as amended Aug. 31, 1914].

Regulation 4. Five-year Closed Seasons on Certain Game Birds.

A closed season shall continue until September 1, 1918, on the following migratory game birds: Band-tailed pigeons, little brown, sandhill, and whooping cranes, swans, curlew, and all shore birds except the black-breasted and golden plover, Wilson or jack snipe, woodcock, and the greater and lesser yellowlegs.

A closed season shall also continue until September 1, 1918, on wood ducks in Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Pennsylvania, West Virginia, Ohio, Indiana, Illinois, Michigan, Wisconsin, Minnesota, Iowa, Kansas, California, Oregon, and Washington; on rails in California and Vermont; and on woodcock in Illinois and Missouri.

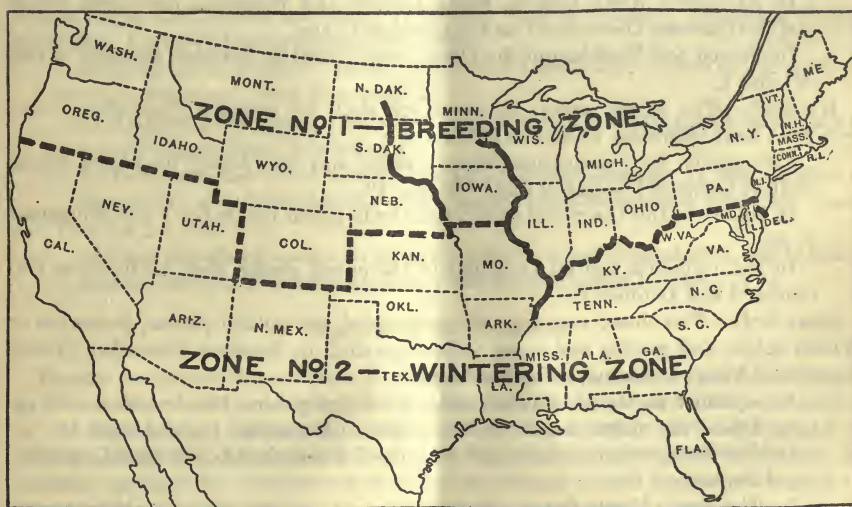
Regulation 5. Closed Season on Certain Navigable Rivers.

On and after January 1, 1915, a closed season shall continue between January 1 and December 31, both dates inclusive, of each year, on all migratory birds passing over or at rest on any of the waters of the main streams of the following navigable rivers, to wit: The Mississippi River between Minneapolis, Minnesota, and Memphis, Tennessee; the Missouri River between Bismarck, North Dakota, and Nebraska City, Nebraska; and on the killing or capture of any of such birds on or over the shores of any of said rivers, or at any point within the limits aforesaid, from any boat, raft, or other device, floating or otherwise, in or on any of such waters [as amended Oct. 1, 1914].

Regulation 6. Zones.

The following zones for the protection of migratory game and insectivorous birds are hereby established:

Zone No. 1, the breeding zone, comprising States lying wholly or in part north of latitude 40° and the Ohio River, and including Maine, New Hampshire, Vermont,



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FIG. 2.—Zones adopted under Federal law protecting migratory birds.

Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Pennsylvania, Ohio, Indiana, Illinois, Michigan, Wisconsin, Minnesota, Iowa, North Dakota, South Dakota, Nebraska, Colorado, Wyoming, Montana, Idaho, Oregon, and Washington—25 States.

Zone No. 2, the wintering zone, comprising States lying wholly or in part south of latitude 40° and the Ohio River and including Delaware, Maryland, the District of Columbia, West Virginia, Virginia, North Carolina, South Carolina, Georgia, Florida, Alabama, Mississippi, Tennessee, Kentucky, Missouri, Arkansas, Louisiana, Texas, Oklahoma, Kansas, New Mexico, Arizona, California, Nevada, and Utah—23 States and the District of Columbia.

Regulation 7. Construction.

For the purposes of regulations 8 and 9, each period of time therein prescribed as a closed season shall be construed to include the first day and to exclude the last day thereof.

Regulation 8. Closed Seasons in Zone No. 1.

Waterfowl [as amended Oct. 1, 1914].—The closed season on waterfowl shall be between December 16 and September 1 next following, except as follows:

Exceptions: In Massachusetts and Rhode Island the closed season shall be between January 1 and October 1.

In Connecticut, New York, Pennsylvania, Idaho, Oregon, and Washington the closed season shall be between January 16 and October 1.

In New Jersey the closed season shall be between February 1 and November 1.

In Minnesota, North Dakota, South Dakota, and Wisconsin the closed season shall be between December 1 and September 7.

Rails.—The closed season on rails, coots, and gallinules shall be between December 1 and September 1 next following, except as follows:

Exceptions: In Massachusetts, New Hampshire, and Rhode Island the closed season shall be between December 1 and August 15.

In Connecticut, Michigan, and New York, and on Long Island the closed season shall be between December 1 and September 16.

In Minnesota, North Dakota, South Dakota, and Wisconsin the closed season shall be between December 1 and September 7; and

In Oregon and Washington the closed season shall be between January 16 and October 1.

Woodcock.—The closed season on woodcock shall be between December 1 and October 1 next following, except as follows:

Exceptions: In Connecticut, Massachusetts, and New Jersey the closed season shall be between December 1 and October 10.

In Rhode Island the closed season shall be between December 1 and November 1; and

In Pennsylvania and on Long Island the closed season shall be between December 1 and October 15.

Shore birds.—The closed season on black-breasted and golden plover, jacksnipe or Wilson snipe, and greater and lesser yellowlegs shall be between December 16 and September 1 next following, except as follows:

Exceptions: In Maine, Massachusetts, New Hampshire, Rhode Island, and on Long Island the closed season shall be between December 1 and August 15.

In New York, except Long Island, the closed season shall be between December 1 and September 16.

In Minnesota, North Dakota, South Dakota, and Wisconsin the closed season shall be between December 1 and September 7; and

In Oregon and Washington the closed season shall be between December 16 and October 1.

Regulation 9. Closed Seasons in Zone No. 2.

Waterfowl [as amended Oct. 1, 1914].—The closed season on waterfowl shall be between January 16 and October 1 next following, except as follows:

Exceptions: In Delaware, Maryland, District of Columbia, Virginia, North Carolina, Alabama, Mississippi, and Louisiana the closed season shall be between February 1 and November 1.

In Florida, Georgia, and South Carolina the closed season shall be between February 16 and November 20.

In Kansas, Missouri, and Oklahoma the closed season shall be between February 1 and September 15.

In Texas, Arizona, and California the closed season shall be between February 1 and October 15.

Rails.—The closed season on rails, coots, and gallinules shall be between December 1 and September 1 next following, except as follows:

Exceptions: In Tennessee and Utah the closed season shall be between December 1 and October 1.

In Missouri the closed season shall be between January 1 and September 15.

In Louisiana the closed season shall be between February 1 and November 1; and

In Arizona and California the closed season on coots shall be between February 1 and October 15.

Woodcock.—The closed season on woodcock shall be between January 1 and November 1, except as follows:

Exceptions: In Delaware and Louisiana the closed season shall be between January 1 and November 15.

In West Virginia the closed season shall be between December 1 and October 1; and

In Georgia the closed season shall be between January 1 and December 1.

Shore birds.—The closed season on black-breasted and golden plover, jacksnipe or Wilson snipe, and greater and lesser yellowlegs shall be between December 16 and September 1 next following except as follows:

Exceptions: In Florida, Georgia, and South Carolina the closed season shall be between February 1 and November 20.

In Alabama, Louisiana, Mississippi, and Texas the closed season shall be between February 1 and November 1.

In Tennessee the closed season shall be between December 16 and October 1.

In Arizona and California the closed season shall be between February 1 and October 15; and

In Utah the closed season on snipe shall be between December 16 and October 1, and on plover and yellowlegs shall be until September 1, 1918.

Regulation 10. Hearings.

Persons recommending changes in the regulations or desiring to submit evidence in person or by attorney as to the necessity for such changes should make application to the Secretary of Agriculture. Whenever possible hearings will be arranged at central points, and due notice thereof given by publication or otherwise as may be deemed appropriate. Persons recommending changes should be prepared to show the necessity for such action and to submit evidence other than that based on reasons of personal convenience or a desire to kill game during a longer open season.

IN WITNESS WHEREOF, I have hereunto set my hand and caused the seal of the United States to be affixed.

Done at the city of Washington, this first day of October, in the year of our Lord one thousand nine hundred and thirteen [SEAL.] and of the Independence of the United States the one hundred and thirty-eighth.

WOODROW WILSON.

By the President:

W. J. BRYAN, *Secretary of State.*

OPEN SEASONS.

All the general open seasons for game prescribed by the various States and by the Provinces of Canada are here brought together in one table. For the sake of simplicity a uniform method is used in both the arrangement of species and statement of seasons. In each case deer and other big game are first considered; then rabbits and squirrels; then upland game birds, such as quail, grouse, pheasants, turkeys, and doves; then shore birds; and finally waterfowl, such as ducks, geese, and brant, but always combining the species which have the same open season. In stating the seasons the plan of the Vermont law, to include the first date but not the last, has been followed consistently.¹ The Vermont scheme has the advantage of showing readily both the open and close seasons, since either may be obtained by reversing the dates of the other.

In some States certain days of the week constitute close seasons throughout the time in which killing is permitted. Hunting on Sunday is prohibited in all of the States and Provinces east of the one hundred and fifth meridian except Illinois, Louisiana, Michigan, Texas, Wisconsin, and Quebec. Mondays constitute a close season for waterfowl in Ohio, and locally in Maryland and North Carolina; and other week days for wild fowl in several favorite ducking grounds in Delaware, Maryland, Virginia, and North Carolina. Hunting is prohibited on election day in Allegany, Baltimore, Cecil, Charles, Frederick, and Harford Counties, Md.; and when snow is on the ground in New Jersey, Delaware, Virginia, and Maryland. The county laws of North Carolina, which are too numerous to be included satisfactorily, are not incorporated in the following table, which otherwise may be regarded as a practically complete résumé of the regulations now in force. The difficulty of securing absolute accuracy in a table of this kind is very great, and the absence in the laws of many States of express legislation as to the inclusion or exclusion of the date upon which seasons open and close makes exactness almost an impossibility.

In the following table the seasons on migratory birds are in accordance with State laws and the amended Federal regulations. Species like the band-tailed pigeon, cranes, curlew, godwit, upland plover, swan, and the smaller shore birds, which are protected until 1918 under the regulations, are not included.

¹ See discussion of this question in Circular No. 43 of the Biological Survey, U. S. Department of Agriculture, 1904, entitled "Definitions of the open and close seasons for game."

OPEN SEASONS FOR GAME IN THE UNITED STATES AND CANADA, 1915.

[The open seasons include the first date, but not the last. To find the close seasons, *reverse the dates*. Seasons which apply only to special counties are placed to the left of the column containing those for the State in general. Species on which the season is closed for a term of years or an indefinite period are grouped at the end of each State under the term "No open season."]

Alabama:*Open seasons.*

Male deer (does protected all the year).....	Nov. 1-Jan. 1.
Squirrel (black, gray, or fox).....	Oct. 1-Mar. 1.
Quail or partridge.....	Nov. 1-Mar. 1.
Ruffed grouse (pheasant), imported pheasant, or other introduced game birds.....	Nov. 15-Dec. 15.
Wild turkey gobblers (hens protected all the year).....	Dec. 1-Apr. 1.
Dove.....	Aug. 1-Mar. 1.
Plover, snipe, yellowlegs, duck, goose, brant.....	Nov. 1-Feb. 1.
Woodcock.....	Nov. 1-Jan. 1.
Rail, coot, mud hen.....	Sept. 1-Dec. 1.

No open season: Elk (1925); curlew, sandpiper, other shore birds, swan (1918).

Alaska:¹*North of latitude 62°—*

Moose (females and yearlings protected all the year), caribou, sheep.....	Aug. 1-Dec. 11.
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South of latitude 62°—

Deer (see exception).....	Aug. 15-Nov. 2.
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Suemeez, and Zarembo Islands..... Aug. 1, 1916.

Exception: Deer on Duke, Gravina, Kodiak, Long, Krusof,

Mountain goat.....	Aug. 1-Feb. 2.
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Moose (females and yearlings protected all the year), caribou, sheep (see exception).....	Aug. 20-Jan. 1.
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Exception: Moose, South Lynn Canal; caribou on the Kenai Peninsula; sheep, Kenai Peninsula, east of long. 150°..... Aug. 20, 1916.

Brown bear.....	Oct. 1-July 2.
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Throughout Territory—

Grouse, ptarmigan, shore birds, waterfowl.....	Sept. 1-Mar. 2.
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Arizona:

Deer (male).....	Oct. 1-Dec. 16.
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Quail (except bobwhite).....	Oct. 15-Feb. 2.
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Wild turkey.....	Oct. 1-Dec. 16.
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Dove and white wings.....	June 1-Feb. 2.
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Gallinule.....	Sept. 1-Dec. 1.
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Rail.....	Oct. 15-Dec. 1.
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Snipe, plover, yellowlegs, coot, duck, goose, brant.....	Oct. 15-Feb. 1.
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No open season: Female deer, spotted fawn, elk, antelope, sheep, goat, bobwhite, grouse, pheasant.

Arkansas:

Deer, bear, wild turkey (gobblers also, Apr. 15-June 1).....	Nov. 11-Jan. 11.
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Quail or partridge.....	Dec. 1-Feb. 1.
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Prairie chicken, pinnated grouse.....	Nov. 1-Dec. 1.
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No open season: Dove.

California:²

Male deer (except spike bucks), districts 1 and 23.....	Aug. 15-Oct. 15.
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In districts 2 and 3.....	Aug. 1-Sept. 15.
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In district 4.....	Sept. 1-Oct. 1.
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Cottontail and bush rabbit, valley and desert quail.....	Oct. 15-Jan. 1.
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Tree squirrel (except in Mendocino County, unprotected).....	Sept. 1-Jan. 2.
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Mountain quail, grouse, districts 1 and 23.....	Sept. 1-Dec. 1.
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In districts 2, 3, and 4.....	Oct. 15-Jan. 1.
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¹ *Alaska:* Game animals or birds may be killed at any time for food or clothing by native Indians or Eskimos, or by miners or explorers in need of food, but game so killed can not be shipped or sold.

² *California:* Seasons fixed by boards of county supervisors are omitted. Of the 30 fish and game districts created under the act of 1915, only 5 are properly hunting districts, 6 are game refuges, and the others are fish districts. The hunting districts are as follows: District No. 1: Del Norte, Siskiyou, Modoc, Humboldt, Trinity, Shasta, Lassen, Tehama, Plumas, Butte, Yuba, Sutter, Sacramento, Amador, Alpine, Calaveras, Tuolumne, Mono, Inyo, Madera, Mariposa, Tulare, Kings, and the parts of Sierra, Nevada, Placer, Eldorado, not in the Tahoe or Truckee River Basin, and the eastern parts of San Joaquin, Stanislaus, Merced, Fresno, and Kern Counties. District No. 2: Mendocino, Glenn, Colusa, Lake, Yolo, Napa, Sonoma, Marin, and Solano Counties. District No. 3: Contra Costa, San Francisco, San Mateo, Alameda, Santa Cruz, Santa Clara, San Benito, Monterey, San Luis Obispo, and the western parts of San Joaquin, Stanislaus, Merced, Fresno, and Kern Counties. District No. 4: Santa Barbara, Ventura, Los Angeles, San Bernardino, Riverside, Orange, San Diego, and Imperial Counties. District No. 23: Comprises the drainage area of Lake Tahoe and the Truckee River.

*Open seasons for game—Continued.***California—Continued.**

	<i>Open seasons.</i>
Sage hen, dove.....	Sept. 1–Dec. 1.
Black-breasted and golden plover, Wilson or jacksnipe, yellowlegs, coot, gallinule, duck (except wood duck), goose, brant.....	Oct. 15–Feb. 1.
Duck, goose, brant.....	Nov. 1–Feb. 1.
<i>No open seasons:</i> Does, spike buck, fawn, elk, antelope, sheep, pheasant, introduced quail or partridge, turkey, swan, rail, band-tailed pigeon, wood duck.	

Colorado:

Rabbit, hare (except jack rabbit, unprotected).....	Oct. 1–Mar. 1.
Prairie chicken, mountain and willow grouse.....	Aug. 15–Oct. 11.
Sage chicken.....	Aug. 1–Sept. 2.
Dove.....	Aug. 15–Sept. 1.
Plover, snipe, yellowlegs, duck, goose, brant.....	Sept. 1–Dec. 16.
Rail, coot, gallinule.....	Sept. 1–Dec. 1.
<i>No open season:</i> Deer, male (1918); elk, antelope, sheep, quail (bobwhite, crested), pheasant, black game, capercaillie (1924); does, partridge, ptarmigan, wild turkey, wild pigeon.	

Connecticut:

Hare, rabbit (except Belgian or German hare, unprotected).....	Oct. 8–Jan. 1. ¹
Gray squirrel, quail, ruffed grouse, pheasant (imported), Hungarian partridge.....	Oct. 8–Nov. 24.
Black-breasted and golden plover, Wilson or English snipe, yellowlegs.....	Sept. 1–Dec. 16.
Woodcock.....	Oct. 10–Nov. 24.
Rail, mud hen, gallinule.....	Sept. 16–Dec. 1.
Duck (except wood duck), goose, brant.....	Oct. 1–Jan. 16.
<i>No open season:</i> Deer ² (June 1, 1917), dove, wood duck (1919), swan (1918).	

Delaware:

Rabbit, hare, quail, partridge, woodcock.....	Nov. 15–Jan. 1.
Squirrel (fox, black, gray).....	Sept. 1–Oct. 16.
Dove (except in Newcastle County, no open season).....	Aug. 1–Jan. 1.
Ortolan or rail, redbird.....	Sept. 1–Nov. 1.
Black-breasted and golden plover, jacksnipe or Wilson snipe, yellowlegs.....	Sept. 1–Dec. 16.
Coot, gallinule.....	Sept. 1–Dec. 1.
Duck (except wood duck), goose, brant.....	Nov. 1–Feb. 1.

District of Columbia:³

Deer meat (sale or possession).....	Sept. 1–Jan. 1.
Rabbit (except English rabbit, Belgian hare), squirrel.....	Nov. 1–Feb. 1.
Quail or partridge.....	Nov. 1–Mar. 15.
Ruffed grouse or pheasant (except English or other imported pheasants raised in inclosures, sale or possession unrestricted), wild turkey.....	Nov. 1–Dec. 26.
Prairie chicken (pinnated grouse).....	Sept. 1–Mar. 15.
Woodcock.....	Nov. 1–Jan. 1.
Plover, snipe, marsh blackbird.....	Sept. 1–Dec. 16.
Redbird.....	Sept. 1–Nov. 1.
Rail or ortolan, coot, gallinule.....	Sept. 1–Dec. 1.
Duck, goose, brant.....	Nov. 1–Feb. 1.

No open season: Dove.**Florida:**

Deer, quail (bobwhite partridge), wild turkey, dove.....	Nov. 20–Mar. 10.
Squirrel.....	Oct. 1–Mar. 1.
Ruffed grouse, imported pheasants (1915).....	Dec. 1–Dec. 20.
Woodcock.....	Nov. 1–Jan. 1.
Plover, snipe, yellowlegs.....	Nov. 20–Feb. 1.
Rail, coot, gallinule.....	Nov. 20–Dec. 1.
Duck, goose, brant.....	Nov. 20–Feb. 16.

Georgia:

Deer (male).....	Oct. 1–Dec. 1.
Cat squirrel.....	Aug. 1–Jan. 1.
Opossum.....	Oct. 1–Mar. 1.
Quail, partridge, wild turkey (gobblers), dove.....	Nov. 20–Mar. 1.
Plover, yellowlegs.....	Nov. 20–Feb. 1.
Snipe.....	Dec. 1–Feb. 1.

¹ *Connecticut:* Between Nov. 24 and Jan. 1, hunting is permitted with dog and ferret only.² Deer, if reported to commissioners within 24 hours, may be killed with shotgun on a person's own land at any time.³ *District of Columbia:* Hunting prohibited in the District, by act of June 30, 1906, except on the marshes of the Eastern Branch above the Anacostia Bridge and on the Virginia side of the Potomac, but in this area no birds may be shot within 200 yards of any bridge or dwelling.

*Open seasons for game—Continued.***Georgia—Continued.**

	<i>Open seasons.</i>
Woodcock, wood duck.....	Dec. 1-Jan. 1.
Rail, coot, gallinule.....	Sept. 1-Dec. 1.
Duck (except wood duck), goose, brant.....	Nov. 20-Feb. 16.
<i>No open season:</i> Does and fawns, pheasant or ruffed grouse, wild turkey hens, imported game birds (Dec. 1, 1916), fox squirrel (Jan. 1, 1918).	

Idaho:¹

Deer (male) (see exception), goat.....	Sept. 1-Dec. 1.
<i>Exception:</i> Deer in Bonner, Clearwater, Idaho, Kootenai, Latah, Nez Perce, and Shoshone Counties.....	
Elk (male) in Bingham, Bonneville, Fremont, and Teton Counties only (no open season in rest of State).....	Sept. 20-Dec. 20.
Quail (except in Lemhi County, Mar. 5, 1919).....	Sept. 1-Jan. 1.
Partridge, pheasant, grouse (except north of Salmon River, Sept. 1-Dec. 1).....	Nov. 1-Dec. 1.
Turtle dove (except in Fremont County, Aug. 15-Dec. 1), sage hen.....	Aug. 15-Dec. 1.
Plover, snipe, yellowlegs.....	July 15-Dec. 1.
Rail, coot, gallinule.....	Sept. 1-Dec. 16.
Duck, goose, brant.....	Sept. 1-Dec. 1.
<i>No open season:</i> Moose, antelope, caribou, sheep, buffalo, does, fawns, cow and yearling elk, prairie chicken, pinnated grouse, imported pheasants, swan (1918).	

Illinois:

Rabbit.....	Aug. 31-Feb. 1.
Squirrel (gray, red, fox, black).....	Aug. 1-Feb. 1.
Quail.....	Nov. 11-Dec. 10.
Prairie chicken.....	Oct. 1-Oct. 16.
Imported pheasants (cocks).....	Oct. 1-Oct. 6.
Mourning dove.....	Aug. 15-Sept. 1.
Plover, snipe, yellowlegs, duck, goose, brant.....	Sept. 1-Dec. 16.
Coot.....	Sept. 1-Dec. 1.
<i>No open season:</i> Deer; wild turkey; female imported pheasants; partridges; sand grouse (1925); ruffed grouse; partridge; blue, mountain, and valley quail; Hungarian partridge; capercailzie; heath hen; black grouse; woodcock; rail; swan; smaller shore birds (1920); wood duck (1918).	

Indiana:

Rabbit.....	Apr. 1-Jan. 10.
Squirrel.....	July 1-Nov. 1.
Quail, ruffed grouse.....	Nov. 10-Dec. 21.
Prairie chicken.....	Oct. 15-Nov. 1.
Woodcock.....	Oct. 1-Dec. 1.
Black-breasted and golden plover, Wilson or jacksnipe, yellowlegs, duck, goose, brant.....	Sept. 1-Dec. 16.
Rail, coot, gallinule.....	Sept. 1-Dec. 1.
<i>No open season:</i> Deer, Hungarian partridge, imported pheasant, wild turkey, dove, wood duck.	

Iowa:

Squirrel (gray, timber, or fox).....	Sept. 1-Jan. 1.
Quail, ruffed grouse or pheasant, wild turkey.....	Nov. 1-Dec. 15.
Prairie chicken (pinnated grouse), rail, coot, gallinule.....	Sept. 1-Dec. 1.
Woodcock.....	Oct. 1-Dec. 1.
Black-breasted and golden plover, Wilson or jacksnipe, yellowlegs, duck, goose, brant.....	Sept. 1-Dec. 16.
<i>No open season:</i> Deer, elk, pheasants (English, Mongolian, Chinese, ringneck), Hungarian partridge (Oct. 1, 1917); turtle dove, wood duck.	

Kansas:

Fox squirrel (red, gray, and black, no open season).....	Sept. 1-Jan. 1.
Plover.....	Aug. 1-May 1.
Snipe.....	Sept. 1-May 1.
Duck, goose, brant.....	Sept. 1-Apr. 16.
<i>No open season:</i> Deer, antelope (1921); quail, prairie chicken, pheasants (English, Mongolian, or Chinese), Hungarian partridge, wood duck (1918); grouse.	

Kentucky:

Deer.....	Sept. 1-Mar. 1.
Rabbit ²	Nov. 15-Sept. 15.
Squirrel (black, or fox).....	June 15-Sept. 15.
	Nov. 15-Feb. 1.

¹ *Idaho:* In Bannock, Bear Lake, Cassia, Franklin, Oneida, Power, and Twin Falls Counties hunting big game, quail, and Mongolian pheasants is prohibited until Mar. 11, 1920.

² *Kentucky:* Rabbits may be taken with dogs or snares between Sept. 15 and Nov. 15.

*Open seasons for game—Continued.***Kentucky—Continued.**

	<i>Open seasons.</i>
Quail, partridge, pheasant (ruffed grouse).....	Nov. 15-Jan. 1.
Wild turkey.....	Sept. 1-Feb. 1.
Dove.....	Aug. 1-Feb. 1.
Woodcock.....	Nov. 1-Jan. 1.
Black-breasted and golden plover, Wilson or jacksnipe, yellowlegs.....	Sept. 1-Dec. 16.
Rail, coot, gallinule.....	Sept. 1-Dec. 1.
Duck, goose, brant.....	Oct. 1-Jan. 16.

No open season: Pheasants (English, ringneck, Mongolian, or Chinese).

Louisiana:

Deer (except does, Oct. 15-Jan. 6) ¹	Sept. 15-Jan. 6.
Bear.....	Nov. 1-Feb. 1.
Raccoon, opossum.....	Nov. 1-Feb. 16.
Squirrel.....	Oct. 1-Feb. 16.
Quail, wild turkey (except hens, Dec. 1, 1915), dove, Florida duck (black mallard).....	Nov. 1-Feb. 16.
Prairie chicken, pheasant (imported or native).....	Dec. 1-Jan. 1.
Woodcock.....	Nov. 15-Jan. 1.
Black-breasted and golden plover, snipe, yellowlegs, rail, coot, gallinule, duck, goose, brant.....	Nov. 1-Feb. 1.

No open season: Fawns, elk (1919).

Maine:²

Deer (see exception).....	Oct. 1-Dec. 16.
<i>Exception:</i> In Androscoggin, Cumberland, Kennebec, Knox, Lincoln, Sagadahoc, Waldo, and York Counties	Nov. 1-Dec. 1.
Hare, rabbit.....	Oct. 1-Apr. 1.
Gray squirrel.....	Sept. 1-Nov. 1.
Ruffed grouse, partridge (see exception).....	Sept. 15-Nov. 15
<i>Exception:</i> Androscoggin, Cumberland, Kennebec, Knox, Lin- coln, Sagadahoc, Waldo, and York Counties.....	Oct. 1-Dec. 1.
Woodcock (see exception).....	Oct. 1-Nov. 15.
<i>Exception:</i> Androscoggin, Cumberland, Kennebec, Knox, Lin- coln, Sagadahoc, Waldo, and York Counties	Oct. 1-Dec. 1.
Plover, snipe, yellowlegs.....	Aug. 15-Dec. 1.
Rail, coot, gallinule.....	Sept. 1-Dec. 1.
Duck, goose, brant.....	Sept. 1-Dec. 16.

No open season: Deer, Cross and Scotch Islands (1919), Mount Desert Island; bull moose (1919); cow and calf moose; caribou (1917); quail, Hungarian partridge, pheasant, black game, capercaillie, cock of the woods, dove, wood duck, and the smaller shore birds.

Maryland:

Deer, rabbit, squirrel.....	Nov. 10-Dec. 25.
Quail, ruffed grouse, wild turkey, imported pheasant, woodcock.....	Nov. 10-Dec. 25.
Dove.....	Aug. 15-Dec. 25. ³
Plover, snipe, yellowlegs.....	Sept. 1-Dec. 16.
Reedbird, sora (water rail or ortolan).....	Sept. 1-Nov. 1.
Coot, gallinule.....	Sept. 1-Dec. 1.
Duck, goose, brant.....	Nov. 1-Feb. 1. ⁴

¹ *Louisiana:* Deer season fixed by conservation commission.

² *Maine:* All hunting is prohibited on Kineo Point, Piscataquis County; on Back Bay above; Grand Trunk Railroad bridge, Cumberland County; and until 1919 in town of Perkins, southern point of Swan Island.

³ *Maryland:* Dove, Aug. 15-Dec. 25, except in Baltimore, Sept. 1-Oct. 1; Dorchester, Aug. 15-Jan. 1; Frederick, Aug. 1-Oct. 1; Kent, July 16-Dec. 24; Somerset, Aug. 10-Jan. 1; Talbot, Aug. 15-Jan. 1; Washington, Aug. 1-Sept. 1. In Allegany, Carroll, Harford, and Sassafras Rivers on Mondays, Wednesdays, Fridays, and Saturdays, Jan. 1-Feb. 1; shooting wildfowl in Harford County prohibited after 2 p. m. Anne Arundel, on Magothy River, shooting permitted only on Tuesdays, Thursdays, and Saturdays; on Rhode and West Rivers on Mondays, Wednesdays, and Fridays; on Severn River on Mondays, Wednesdays, and Saturdays. Cecil County, on Bohemia, Elk, and Sassafras Rivers on Mondays, Wednesdays, Fridays, and Saturdays. Dorchester, on Choptank River on Tuesdays, Thursdays, and Saturdays. Kent, on Chester River above Cliff City and Spaniard Point on Mondays, Fridays, and Saturdays. Susquehanna Flats, on Mondays, Wednesdays, and Fridays in November and December and also on Saturdays during rest of season.

⁴ North of a line extending from Turkey Point Lighthouse, Cecil County, and half a mile north of Spesutia Island to Oakington, Harford County, and throughout Harford County, wildfowl shooting permitted only on Mondays, Wednesdays, and Fridays, Nov. 1-Jan. 1 and Mondays, Wednesdays, Fridays, and Saturdays, Jan. 1-Feb. 1; shooting wildfowl in Harford County prohibited after 2 p. m. Anne Arundel, on Magothy River, shooting permitted only on Tuesdays, Thursdays, and Saturdays; on Rhode and West Rivers on Mondays, Wednesdays, and Fridays; on Severn River on Mondays, Wednesdays, and Saturdays. Cecil County, on Bohemia, Elk, and Sassafras Rivers on Mondays, Wednesdays, Fridays, and Saturdays. Dorchester, on Choptank River on Tuesdays, Thursdays, and Saturdays. Kent, on Chester River above Cliff City and Spaniard Point on Mondays, Fridays, and Saturdays. Susquehanna Flats, on Mondays, Wednesdays, and Fridays in November and December and also on Saturdays during rest of season.

Open seasons for game—Continued.

Massachusetts:

	<i>Open seasons.</i>
Deer (third Monday in November to the following Saturday, inclusive).....	Nov. 15-20, 1915.
Hare or rabbit.....	Oct. 12-Mar. 1.
Gray squirrel.....	Oct. 12-Nov. 13.
Quail (except in Essex County, Oct. 12, 1919), ruffed grouse or partridge, woodcock..	Oct. 12-Nov. 13.
Introduced pheasants in Barnstable, Berkshire, Essex, Hampden, Middlesex, Norfolk, and Worcester Counties only.....	Oct. 12-Nov. 13.
Black-breasted and golden plover, jacksnipe, yellowlegs, rail, gallinule, quark (mud hen).....	Aug. 15-Dec. 1.
Duck (except wood duck), goose, brant.....	Oct. 1-Jan. 1.
<i>No open season:</i> Moose, dove, wild or passenger pigeon, prairie chicken, Hungarian partridge, pheasants (English, golden, Mongolian), ¹ killdeer, piping plover, wood duck, swan, heath hen, Bartramian sandpiper (upland plover).	

Michigan:

Deer (see exceptions).....	Nov. 10-Dec. 1.
<i>Exceptions:</i> Deer in red coat, fawn in spotted coat; all deer on Bois Blanc Island (1918); in Berrien, Calhoun, Genesee, Ingham, Jackson, Kalamazoo, Oakland, and St. Clair Counties (1920).	
Rabbit.....	Oct. 1-Mar. 2.
Ruffed grouse (partridge), woodcock.....	Oct. 1-Dec. 1.
Plover, snipe, yellowlegs, duck, goose, brant.....	Sept. 1-Dec. 16.
Rail, coot, gallinule.....	Sept. 16-Dec. 1.
<i>No open season:</i> Elk, moose, caribou, European partridge, dove, swan; squirrel, quail, imported pheasants, black game, capercailzie, hazel grouse, Canada or spruce grouse, prairie chicken, wild turkey, smaller shorebirds (1920); wood duck (1918).	

Minnesota:

Deer, bull moose.....	Nov. 10-Nov. 30.
Quail, partridge, ruffed grouse (pheasant).....	Oct. 1-Dec. 1.
Sharp-tailed or white-breasted grouse, prairie chicken (pinnated grouse), Wilson or jacksnipe.....	Sept. 7-Nov. 7.
Rail, coot, gallinule, duck, goose, brant.....	Sept. 7-Dec. 1.
<i>No open season:</i> Elk, cow moose, caribou, fawn, imported pheasants; dove, woodcock, upland and golden plover, wood duck (1918).	

Mississippi:²

Deer (buck), bear.....	Nov. 15-Mar. 1.
Quail or partridge.....	Nov. 1-Mar. 1.
Wild turkey gobblers.....	Jan. 1-May 1.
Dove.....	July 1-Mar. 1.
Plover, chorook, grosbec, Wilson or jacksnipe, yellowlegs, duck, goose, brant.....	Nov. 1-Feb. 1.
Coot (poule d'eau), rail (mud hen), gallinule.....	Sept. 1-Dec. 1.
Cedar bird.....	Sept. 1-Mar. 1.
<i>No open season:</i> Does and spotted fawns, turkey hens.	

Missouri:

Deer (buck), wild turkey.....	Nov. 1-Jan. 1.
Squirrel (gray, black, fox).....	June 1-Jan. 1.
Quail (bobwhite, partridge).....	Nov. 10-Jan. 1.
Dove.....	Aug. 1-Nov. 11.
Plover.....	Sept. 1-Dec. 16.
Snipe, yellowlegs.....	Sept. 15-Dec. 16.
Rail, coot, gallinule.....	Sept. 15-Jan. 1.
Duck, goose, brant.....	Sept. 15-Feb. 1.
<i>No open season:</i> Does, fawns under 1 year of age, ruffed grouse (pheasant), prairie chicken (pinnated grouse), imported pheasants, woodcock, and other game birds.	

Montana:

Deer.....	Oct. 1-Dec. 15.
Elk in Sweetgrass, Stillwater, Park, Gallatin, Madison, Teton, Flathead; Beaverhead east of Oregon Short Line and parts of Missoula and Powell Counties, only.....	Oct. 1-Dec. 15.
Pheasant, partridge, prairie chicken, sage hen, fool hen, grouse (see exception).....	Sept. 15-Oct. 16.
<i>Exception:</i> In Custer, Dawson, Richland, Sheridan, Valley, Phillips, Rosebud, Big Horn, Fallon, and Prairie Counties.....	
	Sept. 1-Oct. 1.

¹ *Massachusetts:* Commissioners may open season on pheasants.

² *Mississippi:* Local regulations of boards of supervisors also in force.

*Open seasons for game—Continued.***Montana—Continued.***Open seasons.*

Black-breasted and golden plover, Wilson or jacksnipe, yellowlegs, duck, goose, brant.....	Sept. 1–Dec. 16.
Rail, coot, gallinule.....	Sept. 1–Dec. 1.
<i>No open season:</i> Elk (except as above), sheep, goat (1918); moose, caribou, antelope, bison or buffalo, quail, imported pheasant, dove.	

Nebraska:

Squirrel (gray, red, fox, timber).....	Oct. 1–Dec. 1.
Quail.....	Nov. 1–Nov. 16.
Dove.....	July 15–Sept. 1.
Prairie chicken, sage chicken, grouse, rail, coot, gallinule.....	Sept. 1–Dec. 1.
Yellowlegs, Wilson or jacksnipe, duck, goose, brant.....	Sept. 1–Dec. 16.
<i>No open season:</i> Deer, elk, antelope, partridge, pheasant, ptarmigan, imported game birds, wild pigeon, wild turkey, curlew, crane, swan.	

Nevada:¹

Deer (except fawns, no open season), antelope.....	Sept. 15–Oct. 16.
Grouse, mountain and valley quail, prairie chicken.....	Sept. 15–Jan. 1.
Sage hen.....	July 15–Feb. 16.
Woodcock.....	Nov. 1–Jan. 1.
Black-breasted and golden plover, Wilson or jacksnipe, yellowlegs.....	Sept. 15–Dec. 16.
Rail, coot, gallinule.....	Sept. 1–Dec. 1.
Duck.....	Oct. 1–Jan. 1.
Goose, brant.....	Oct. 1–Jan. 16.
<i>No open season:</i> Mountain sheep, goats, pheasants (1920).	

New Hampshire:²

Deer in Coos County.....	Oct. 15–Dec. 16.
Deer in Carroll and Grafton Counties.....	Nov. 1–Dec. 16.
Deer in rest of State.....	Dec. 1–Dec. 16.
Hare, rabbit.....	Oct. 1–Mar. 1.
Quail, partridge, ruffed grouse, woodcock.....	Oct. 1–Dec. 1.
Black-breasted and golden plover, Wilson or jacksnipe, yellowlegs, rail, coot, gallinule.....	Aug. 15–Dec. 1.
Duck (except wood duck), goose, brant.....	Sept. 1–Dec. 16.
<i>No open season:</i> Elk, moose, caribou, dove, pheasant, European partridge, killdeer, upland plover, Bartramian sandpiper, wood duck; gray squirrel (1919).	

New Jersey:

Deer ³ (no open season for fawns).....	Oct. 13, 20, 27, and Nov. 3.
Rabbit, squirrel, quail, ruffed grouse (partridge), prairie chicken, Hungarian partridge, English or ringneck pheasant cocks.....	Nov. 10–Dec. 16.
Woodcock.....	Oct. 10–Dec. 1.
Reedbird.....	Sept. 1–Nov. 1.
Black-breasted and golden plover, English (Wilson) snipe (jacksnipe), yellowlegs.....	Sept. 1–Dec. 16.
Marsh hen, rail, coot, gallinule.....	Sept. 1–Dec. 1.
Duck (except wood duck), goose, brant.....	Nov. 1–Feb. 1.
<i>No open season:</i> Female English or ringneck pheasants, wild turkey (1919); wood duck (1918); dove, wild pigeon, upland plover, swan.	

New Mexico:

Deer (with horns):	
North of latitude 35°.....	Oct. 16–Nov. 6.
South of latitude 35°.....	Oct. 25–Nov. 26.
Squirrel (tassel-eared gray).....	June 1–Dec. 1.
Quail (except bobwhite).....	Oct. 25–Jan. 1.
Grouse.....	Sept. 16–Nov. 26.
Wild turkey:	
North of latitude 35°.....	Nov. 1–Jan. 1.
South of latitude 35°.....	Oct. 25–Nov. 26.
Turtle dove.....	Aug. 16–Oct. 1.
Plover, snipe, yellowlegs.....	Sept. 1–Dec. 16.
Rail, coot, gallinule.....	Sept. 1–Dec. 1.
Duck, goose, brant.....	Oct. 1–Jan. 16.
<i>No open season:</i> Does, Sonoran deer, elk, sheep, goat, antelope, buffalo, bobwhite quail, pheasant, ptarmigan, prairie chicken, sage hen, wild pigeon, swan (1920).	

¹ Nevada: County commissioners may change dates of close seasons on deer, antelope, and sage hens (without altering length), and may shorten open seasons on other game.

² New Hampshire: Governor and council may suspend open season in time of excessive drought.

³ New Jersey: Not applicable to possession of imported deer properly tagged.

*Open seasons for game—Continued.***New York:**¹

	<i>Open seasons.</i>
Deer, with horns not less than 3 inches long, in Adirondack region ²	Oct. 1–Nov. 16.
<i>Exception:</i> Deer having horns not less than 3 inches in length in Ulster County and towns of Neversink, Cochecton, Tusten, Highland, Lumberland, Forestburg, Bethel, and all of towns of Mamakating and Thompson south of Newburgh and Cochecton turnpike in Sullivan County, and Deer Park in Orange County.....	
	Nov. 1–Nov. 16.
Varying hare, rabbit ³	Oct. 1–Feb. 1.
Squirrel, ³ black, gray, or fox (no open season in corporate limits of city or village).....	Oct. 1, Nov. 16.
Woodcock.....	Oct. 1–Nov. 16.
Grouse, partridge ³	Oct. 1–Dec. 1.
Pheasants, males only.....	{Oct. 21, Oct. 23, Nov. 4, Nov. 11. ⁴
Black breasted and golden plover, snipe, yellowlegs, rail, coot, gallinule.....	Sept. 16–Dec. 1.
Waterfowl (except wood duck and swan).....	Oct. 1–Jan. 11.
<i>No open season:</i> Elk, moose, caribou, antelope, female deer and fawns, quail, Hungarian or European gray-legged partridge, dove, wood duck, swan.	

New York—Long Island:

Varying hare, rabbit (cottontail), squirrel (black, gray, fox), quail, pheasants (males only), grouse.....	Nov. 1–Jan. 1.
Woodcock.....	Oct. 15–Dec. 1.
Black-breasted and golden plover, jacksnipe, yellowlegs.....	Aug. 15–Dec. 1.
Rail, coot, mud hen, gallinule.....	Sept. 16–Dec. 1.
Waterfowl (except wood duck and swan).....	Oct. 1–Jan. 11.
<i>No open season:</i> Deer, dove, wood duck, swan.	

North Carolina:⁴

Deer.....	Oct. 1–Feb. 1.
Quail, wild turkey, dove.....	Nov. 1–Mar. 1.
Black-breasted and golden plover, jacksnipe or Wilson snipe, yellowlegs.....	Sept. 1–Dec. 16.
Woodcock.....	Nov. 1–Jan. 1.
Rail, coot, gallinule.....	Sept. 1–Dec. 1.
Duck, goose, brant.....	Nov. 1–Feb. 1.

North Dakota:

Prairie chicken (pinnated grouse), sharp-tailed (white-breasted) grouse, golden plover, snipe.....	Sept. 7–Nov. 2.
Woodcock.....	Oct. 1–Nov. 2.
Rail, coot, gallinule, duck, goose, brant.....	Sept. 7–Dec. 1.
<i>No open season:</i> Deer (1920), elk, moose, antelope, quail, partridge, English pheasant, Chinese ringneck pheasant, Hungarian partridge, dove, swan, crane.	

Ohio:

Rabbit.....	Nov. 15–Dec. 5.
Squirrel.....	Sept. 15–Oct. 21.
Raccoon.....	Nov. 1–Mar. 2.
Woodcock.....	Oct. 1–Dec. 1.
Rail, coot, gallinule.....	Sept. 1–Dec. 1.
Plover, snipe, yellowlegs, duck, goose, brant.....	Sept. 1–Dec. 16. ⁵
<i>No open season:</i> Quail, ruffed grouse, introduced pheasant, Hungarian or gray partridge, dove (Nov. 15, 1917), wood duck, swan (1918).	

¹ *New York:* When date of open or close season falls on Sunday, season opens or closes on the preceding Saturday.

² The Adirondack region comprises the counties of Clinton, Essex, Franklin, Fulton, Hamilton, Herkimer, Oswego, Saratoga, St. Lawrence, Warren, and Washington, and that part of Jefferson, Lewis, and Oneida Counties lying east of the Utica & Black River R. R. from Utica to Ogdensburg.

³ Seasons on upland game shortened by order of conservation commission as follows: Cotton-tail rabbit in Richmond County, Oct. 1–Nov. 15 and Jan. 1–Feb. 1; partridge and squirrel in Genesee County, no open season in 1915. Pheasants are protected until Oct. 1, 1916, in the counties of Chenango, Clinton, Delaware, Essex, Franklin, Herkimer, Lewis, Montgomery, Oneida, Otsego, St. Lawrence, Schenectady, Warren, and Washington; and until Oct. 1, 1917, in Cattaraugus and Chataqua.

⁴ *North Carolina:* For county seasons see poster No. 33 of the Biological Survey, U. S. Department of Agriculture.

⁵ *Ohio:* Sundays and Mondays are close seasons for ducks and other waterfowl.

Open seasons for game—Continued.

Oklahoma: ¹		<i>Open seasons.</i>
Deer (male).....		Nov. 1–Dec. 1.
Quail, Mexican (blue)		Nov. 30–Jan. 1
Wild turkey (additional season for gobblers, Mar. 15–Apr. 15).....		Nov. 15–Jan. 1.
Woodcock.....		Nov. 1–Jan. 1.
Black-breasted and golden plover, Wilson or jacksnipe, yellowlegs		Sept. 1–Dec. 16.
Rail, coot, gallinule		Sept. 1–Dec. 1.
Duck (except wood duck), goose, brant.....		Sept. 15–Feb. 1.
<i>No open season:</i> Does, prairie chicken, wild pigeon, imported pheasant, dove, crane, long-billed curlew, wood duck; antelope (1918).		
Oregon:		
<i>District No. 1,² west of Cascades:</i>		
Deer (male).....		Aug. 15–Nov. 1.
Silver gray squirrel, dove		Sept. 1–Nov. 1.
Quail in Coos, Curry, Jackson, Josephine only, grouse, Chinese pheasant (except Chinese pheasant in Coos, Curry, and Josephine Counties, no open season; in Jackson, Oct. 1–11).....		Oct. 1–Nov. 1.
Rail, coot, duck, goose (see exceptions).....		Nov. 1–Jan. 16.
<i>Exceptions:</i> In Coos (goose only), Clatsop, Columbia, Multnomah, and Tillamook Counties.....		Oct. 1–Jan. 1.
Duck in Coos County		Oct. 1–Jan. 16.
Blackbreasted and golden plover, Wilson or jacksnipe, yellowlegs (see exception) ..		Nov. 1–Dec. 16.
<i>Exception:</i> In Clatsop, Columbia, Coos, Multnomah, and Tillamook Counties.....		Oct. 1–Dec. 16.
Gallinule, brant.....		Oct. 1–Jan. 16.
<i>No open season:</i> Does and spotted fawn, moose, elk, antelope, caribou, sheep, goat, quail (except as above), pheasant (silver, golden, Reeves, and English), Hungarian partridge, bobwhite, prairie chicken, Franklin grouse, fool hen, wild turkey, shore birds (except as above), wild pigeon, wood duck, swan.		
<i>District No. 2,² east of Cascades</i> (open season same as in district No. 1, except as follows):		
Chinese pheasant in Union County and quail in Klamath County ..		Oct. 1–Oct. 11.
Ruffed grouse, native pheasant, blue or sooty grouse.....		Aug. 15–Nov. 1
Prairie chicken in Sherman, Union, and Wasco Counties only.....		Oct. 1–Oct. 16.
Sage hen.....		July 15–Sept. 1.
Black-breasted and golden plover, Wilson or jacksnipe, yellowlegs		Oct. 1–Dec. 16.
Rail, coot, duck, goose ³		Oct. 1–Jan. 16.
<i>No open season:</i> Silver gray squirrel, imported pheasant.		
Pennsylvania:		
Deer—male with horns 2 inches above the hair (see exception).....		Dec. 1–Dec. 16.
<i>Exception:</i> No open season in Cambria, Clarion, Chester, Fayette, Forest, Jefferson, Somerset, Warren, and Westmoreland Counties.		
Bear.....		Oct. 15–Dec. 16.
Hare, rabbit.....		Nov. 1–Dec. 1.
Squirrel (gray, black, fox), quail, ruffed grouse, ringneck pheasant, wild turkey, Hungarian partridge, woodcock, blackbird		Oct. 15–Dec. 1.
Reedbird.....		Sept. 1–Nov. 1.
Black-breasted and golden plover, Wilson or jacksnipe, yellowlegs.....		Sept. 1–Dec. 16.
Rail, coot, mud hen, gallinule.....		Sept. 1–Dec. 1.
Wild waterfowl—duck, goose, brant, loon, grebe.....		Oct. 1–Jan. 16.
<i>No open season:</i> Elk (1921); upland or grass plover, wood duck (1918); does, dove, killdeer plover.		
Rhode Island:		
Gray squirrel, hare, rabbit, quail or bobwhite, ruffed grouse or partridge		Nov. 1–Jan. 1.
Woodcock.....		Nov. 1–Dec. 1.
Plover, snipe, yellowlegs, rail, coot, gallinule		Aug. 15–Dec. 1.
Duck, goose, brant.....		Oct. 1–Jan. 1.
<i>No open season:</i> Deer, ⁴ dove, pheasant, Hungarian partridge (1920); wood duck, swan, smaller shore birds (1918).		

¹ *Oklahoma:* No open season for deer, bear, and wild turkeys in Blaine, Caddo, Comanche, Kiowa, and Major Counties.

² *Oregon:* District No. 1, west of Cascades, includes Benton, Clackamas, Clatsop, Columbia, Coos, Curry, Douglas, Jackson, Josephine, Lane, Lincoln, Linn, Marion, Multnomah, Polk, Tillamook, Washington, and Yamhill Counties. District No. 2, east of Cascades, includes all other counties in the State.

³ Unlawful to kill geese at any time on islands or sand bars in the Columbia east of the Cascades or on Deschutes and John Day Rivers south to junction with White River and Thirtymile Creek, respectively.

⁴ *Rhode Island:* Deer injuring crops may be killed at any time by the owner or occupant of the premises under written permit from secretary of state.

*Open seasons for game—Continued.***South Carolina:**

Deer (see exceptions).....	<i>Open seasons.</i> Sept. 1-Jan. 1.
<i>Exceptions:</i> In Berkeley, Clarendon, and Dorchester Counties. Aug. 1-Feb. 1.	
In Barnwell, Florence, and Marion Counties.....	Aug. 1-Jan. 1.
In Orangeburg County.....	No open season.
Squirrel in Chesterfield and York Counties.....	Oct. 1-Jan. 1.
Quail (partridge), wild turkey (see exceptions).....	Nov. 15-Mar. 15.
<i>Exceptions:</i> In Abbeville, Chester, and Lancaster Counties... Dec. 1-Feb. 1.	
Quail in Chesterfield and York Counties.....	Nov. 15-Mar. 1.
Quail in Marlboro County.....	Nov. 15-Feb. 15.
Wild turkey in Orangeburg County.....	No open season.
Dove.....	Aug. 15-Mar. 1.
Woodcock.....	Nov. 1-Jan. 1.
Grackle.....	Oct. 1-Mar. 1.
Black-breasted and golden plover, Wilson or jacksnipe, yellowlegs.....	Nov. 20-Feb. 1.
Reedbird.....	Sept. 1-Nov. 1.
Rail, coot, gallinule.....	Sept. 1-Dec. 1.
Duck, goose, brant.....	Nov. 20-Feb. 16.

South Dakota:

Deer (except fawns, no open season).....	Nov. 1-Dec. 1.
Partridge, grouse, prairie chicken, golden plover, snipe, yellowlegs.....	Sept. 10-Oct. 10.
Rail, coot, gallinule.....	Sept. 7-Dec. 1.
Woodcock.....	Oct. 1-Oct. 10.
Duck, goose, brant.....	Sept. 10-Dec. 1.
<i>No open season:</i> Elk, antelope, mountain sheep, quail, dove, upland plover, imported pheasants.	

Tennessee:

Squirrel.....	June 1-Jan. 1.
Quail or partridge (see exceptions), wild turkey (additional season for gobblers, Apr. 1-25).....	Nov. 15-Jan. 1.
<i>Exceptions.</i> Quail, in White (1918), Chester, Fayette, Hardeman, and Haywood counties.....	Dec. 15-Mar. 1.
Grouse, pheasant (except imported species).....	Nov. 1-Mar. 1.
English pheasant.....	Dec. 1-Jan. 1.
Dove.....	Aug. 15-Jan. 1.
Woodcock.....	Nov. 1-Jan. 1.
Black-breasted and golden plover, Wilson or jacksnipe, yellowlegs.....	Oct. 1-Dec. 16.
Rail, coot, mud hen, gallinule.....	Oct. 1-Dec. 1.
Duck, goose, brant.....	Oct. 1-Jan. 16.
<i>No open season:</i> Deer (1917), ring-necked and Mongolian pheasants, robin, meadow lark.	

Texas:

Deer (male).....	Nov. 1-Jan. 1.
Quail or partridge.....	Dec. 1-Feb. 1.
Wild turkey.....	Dec. 1-Apr. 1.
Dove.....	Sept. 1-Mar. 1.
Woodcock.....	Nov. 1-Jan. 1.
Black-breasted and golden plover, Wilson or jacksnipe, yellowlegs.....	Nov. 1-Feb. 1.
Rail, coot, gallinule.....	Sept. 1-Dec. 1.
Duck, goose, brant.....	Oct. 15-Feb. 1.
<i>No open season:</i> Does, spotted fawns; antelope, sheep, prairie chicken, or pinnated grouse, introduced pheasants (1916).	

Utah:

Deer (male—with horns visible above the head) (see exception).....	Oct. 15-Nov. 1.
<i>Exception:</i> Nonresident not permitted to kill deer.	
Quail in Carbon, Davis, Salt Lake, San Pete, Sevier, Uintah, Utah, and Weber Counties.....	Oct. 1-Nov. 1.
Quail in Garfield, Kane, and Washington Counties.....	Sept. 1-Feb. 1.
Quail in Iron County.....	Oct. 1-Dec. 1.
Sage hen (see exception), blue and willow grouse.....	Sept. 1-Sept. 16.
<i>Exception:</i> Sage hen in Rich and Uintah Counties.....	Aug. 15-Sept. 16.
Dove.....	Aug. 15-Sept. 1.
Snipe.....	Oct. 1-Dec. 16.
Duck, goose (see exception).....	Oct. 1-Jan. 1.
<i>Exception:</i> In Grand, Kane, San Juan, Uintah, and Washington Counties.....	Oct. 1-Jan. 16.

Open seasons for game—Continued.

Utah—Continued.		Open seasons.
Rail, coot, gallinule.....		Oct. 1–Dec. 1.
<i>No open season:</i> Does, fawns, elk, antelope, sheep, quail (except as above), partridge, prairie chicken, pheasants (Chinese, English, Mongolian), robin, shore birds (except snipe), swan.		
Vermont: ¹		
Deer.....		Nov. 15–Dec. 6.
Hare, rabbit.....		Sept. 15–Mar. 1.
Gray squirrel, quail, ruffed grouse (partridge).....		Sept. 15–Dec. 1.
Woodcock.....		Oct. 1–Dec. 1.
Black-breasted and golden plover, English snipe, yellowlegs, coot, gallinule.....		Sept. 1–Dec. 1.
Duck (except wood duck), goose, brant.....		Sept. 16–Dec. 16.
<i>No open season:</i> Elk (1923); moose, caribou, fawns, pheasants, European partridge, dove, upland plover, rail, wood duck, swan.		
Virginia: ²		
Deer (except in Brunswick and Greensville Counties, Oct. 1–Feb. 1; Surry and Prince George, Oct. 1–Jan. 1).....		Sept. 1–Dec. 1.
Rabbit.....		Nov. 1–Feb. 1. ³
Squirrel—		
Brunswick and Greensville Counties.....	Nov. 1–Feb. 1. ⁴	
Isle of Wight and Southampton Counties (gray or fox).....	Sept. 1–Jan. 15.	
Warren County.....	Nov. 15–Jan. 1.	
Opossum in Halifax County.....	Oct. 15–Feb. 1.	
Quail or partridge, pheasant or grouse, wild turkey (see exception).....		Nov. 1–Feb. 1.
<i>Exception:</i> West of the Blue Ridge.....		
Nov. 1–Jan. 1.		
Dove in Brunswick and Greensville Counties.....	Aug. 15–Jan. 15.	
Woodcock, summer or wood duck.....		Nov. 1–Jan. 1.
Black-breasted and golden plover, jacksnipe or Wilson snipe, yellowlegs.....		Sept. 1–Dec. 16.
Rail, coot, mud hen, gallinule.....		Sept. 1–Dec. 1.
Reedbird.....		Sept. 1–Nov. 1.
Winter waterfowl ⁵ (except in Brunswick and Greensville Counties, Nov. 1–Jan. 1).....		Nov. 1–Feb. 1.
<i>No open season:</i> Curlew, willet, robin, snipe, and smaller shore birds, swan, 1918.		
Washington:		
Deer, goat (except east of Cascades, Oct. 1–Nov. 15).....		Sept. 15.–Nov. 1.
Caribou (except west of Cascades, no open season).....		Oct. 1–Nov. 15.
Ruffed grouse, blue grouse, ptarmigan, quail, west of Cascades.....		Sept. 15–Nov. 1.
East of Cascades: Ruffed grouse, blue grouse (except in Yakima County, no open season, and in Asotin, Columbia, Garfield, and Walla Walla Counties Aug. 15–Oct. 2).....		Sept. 1–Nov. 16.
Quail east of Cascades (except bobwhite in Spokane County, Oct. 1–Nov. 16).....		Oct. 1–Oct. 11.
Prairie chicken.....		Sept. 15–Nov. 2.
Sage hens (except in Kittitas County, Oct. 1–Oct. 11).....		Oct. 15–Nov. 2.
Sharp-tailed grouse (see exceptions).....		No open season.
<i>Exceptions:</i> In Adams, Asotin, Columbia, Ferry, Garfield, Lincoln, Okanogan, Walla Walla, and Whitman Counties..		
Sept. 15–Nov. 2.		
In Douglas County.....	Sept. 1–Nov. 2.	
In Kittitas County.....	Oct. 1–Oct. 11.	
English, Mongolian, and Reeves pheasants (see exceptions).....		Oct. 1–Oct. 15.
<i>Exceptions:</i> In Mason and Thurston Counties and east of Cascades.....		
No open season.		
Chinese pheasant (see exceptions).....		Sept. 15–Nov. 1.
<i>Exceptions:</i> East of Cascades (except in Benton, Spokane, and Yakima Counties, Oct. 1–Oct. 16; Kittitas County, Oct. 1–Oct. 11).....		
No open season.		
Hungarian partridge in Kittitas County.....	Oct. 1–Oct. 11.	
Spokane County.....	Oct. 1–Nov. 16.	

¹ *Vermont:* The governor is authorized to suspend open seasons in time of drought and fix another open season for deer in such event.

² *Virginia:* Boards of supervisors may shorten the open seasons in their counties and make other restrictions not repugnant to law, "and may include in such protection other game not specifically mentioned in this section." (Code 1904, sec. 2070a, as amended in 1906.) These changes are not included in this table.

³ Residents of the State may kill rabbits on their own lands at any time.

⁴ Residents of the State may kill squirrels on their own lands at any time.

⁵ Wild fowl may not be hunted on Wednesdays, Saturdays, and Sundays on Back Bay, Princess Anne County.

*Open seasons for game—continued.***Washington—Continued.***Open seasons.*

Black-breasted and golden plover, Wilson or jacksnipe, yellowlegs.....	Oct. 1-Dec. 16.
Rail, coot, gallinule, duck, goose, brant.....	Oct. 1-Jan. 16. ¹
<i>No open season:</i> Moose, elk (1925); fawns, mountain sheep, squirrels (gray, black, fox), wild turkey, dove, and introduced birds(except as above).	

West Virginia:

Deer (with horns more than 4 inches long—no open season for other deer), ruffed grouse (pheasant), wild turkey.....	Oct. 15-Dec. 1.
Rabbit (except on own land).....	Oct. 15-Jan. 1.
Squirrel (black, gray, red, fox).....	Sept. 15-Dec. 1.
Quail (Virginia partridge).....	Nov. 1-Dec. 1.
Black-breasted and golden plover.....	Sept. 1-Dec. 16.
Jacksnipe or Wilson snipe, yellowlegs.....	Oct. 15-Dec. 16.
Woodcock.....	Oct. 1-Dec. 1.
Rail (ortolan), coot, gallinule.....	Sept. 1-Dec. 1.
Duck (except wood duck), goose, brant.....	Oct. 1-Jan. 16.
<i>No open season:</i> Elk (1923); imported pheasants, capercaillie, and other introduced foreign game birds, dove, wood duck.	

Wisconsin:

Deer (male) in Pierce, Dunn, Eau Claire, Trempeleau, Jackson, Juneau, Sauk, Marathon, Langlade, Oconto, Door, and all counties north (except Polk).....	Nov. 11-Dec. 1.
<i>No open season:</i> Deer in rest of State.	
Rabbit, in Eau Claire, Pierce, Portage, Richland, Waupaca, and Waushara Counties.....	Sept. 10-Feb. 1.
In Dane, Dunn, Green, Green Lake, Juneau, La Crosse, Outagamie, Marinette, Rock, Sheboygan, Trempeleau, Walworth, and Wood Counties.....	Oct. 10-Feb. 1.
In Dodge, Jefferson, Manitowoc, Ozaukee, Washington, and Waukesha Counties.....	Nov. 1-Jan. 1.
Squirrel (gray, fox, black—see exceptions).....	Oct. 10-Feb. 1.
<i>Exceptions:</i> Eau Claire, Portage, Richland, Vernon, Waupaca, and Waushara Counties.....	Sept. 10-Feb. 1.
In Dodge and Jefferson Counties.....	Nov. 1-Jan. 1.
In Kenosha, Ozaukee, Pierce, Racine, Washington, and Waukesha Counties.....	No open season.
Partridge.....	Sept. 7-Nov. 1.
Prairie chicken, grouse: In Adams, Ashland, Barron, Bayfield, Brown, Burnett, Buffalo, Clark, Columbia, Crawford, Dodge, Douglas, Dunn, Eau Claire, Florence, Fond du Lac, Grant, Green, Green Lake, Iowa, Jackson, Juneau, Kewaunee, Lafayette, Marathon, Marinette, Marquette, Monroe, Oconto, Outagamie, Pepin, Pierce, Polk, Portage, Richland, Rock, Rusk, St. Croix, Sawyer, Shawano, Washburn, Waupaca, Waushara, and Wood Counties.....	Sept. 7-Oct. 1.
In Waukesha County.....	Sept. 7-Sept. 16.
In Chippewa and Vernon Counties.....	Sept. 7-Dec. 1.
In rest of State.....	Sept. 7, 1919.
Plover, snipe, coot or mud hen, rail, rice hen, duck, goose, brant.....	Sept. 7-Dec. 1.
<i>No open season:</i> Elk, moose, quail, pheasants (Chinese, English, Mongolian), Hungarian partridge, woodcock, dove, wood duck, swan.	

Wyoming:²

Deer (see exception).....	Oct. 1-Nov. 16.
<i>Exception:</i> In Campbell, Crook, Johnson, Niobrara, Sheridan, and Weston Counties.....	Oct. 15-Nov. 1.
Elk in Lincoln, Park, and Fremont Counties (except Bridger National Forest and north of Big Wind River and south of Sweetwater).....	Sept. 1-Nov. 16.
Grouse (other than sage grouse).....	Sept. 1-Nov. 16.
Sage grouse.....	Aug. 1-Sept. 2.
Black-breasted and golden plover, Wilson or jacksnipe, yellowlegs, duck, goose (see exception).....	Sept. 15-Dec. 16.
<i>Exception:</i> Duck, goose, in Carbon County.....	Sept. 1-Dec. 16.

¹ *Washington:* No open season on waterfowl upon Columbia or Snake Rivers or within $\frac{1}{4}$ mile of their shores in counties of Benton, Columbia, Douglas, Franklin, Garfield, Grant, Kittitas, Klickitat, Walla Walla, Whitman, and Yakima.

² *Wyoming:* Hunting permitted in Lincoln County on Fall River rim or crest in cattle districts 1, 3, and 5 in Wyoming National Forest, Oct. 5-Nov. 30.

Open seasons for game—Continued.

Wyoming—Continued.

Open seasons.

Rail, gallinule.....	Sept. 1-Dec. 1.
Coot, mud hen (see exception).....	Sept. 15-Dec. 1.
Exception: In Carbon County.....	Sept. 1-Dec. 1.
No open season: Elk (except as above); moose, ¹ antelope, quail, Mongolian pheasant (1919); dove, swan.	

Alberta:²

Deer (male), bull moose, caribou.....	Nov. 1-Dec. 15.
Sheep (male), goat.....	Sept. 1-Oct. 15.
Partridge, Hungarian partridge, grouse, prairie chicken, ptarmigan, pheasant (except English, no open season).....	Oct. 1-Dec. 1.
Plover, curlew, sandpiper, snipe, shore birds, coot, rail, crane, duck, ³ swan.....	Sept. 1-Jan. 1.
No open season: Elk, wapiti, buffalo, females of deer, moose, sheep, and young of all big game; antelope (1917).	

British Columbia:⁴

Deer, ⁴ goat, male caribou.....	Sept. 1-Dec. 16.
Bull moose (in Atlin, Cariboo, Columbia, and Skeena Electoral Districts only).....	Sept. 1-Dec. 16.
Male sheep (except in Okanogan, Similkameen, and Yale Electoral Districts, no open season).....	Sept. 1-Nov. 16.
Ruffed grouse (certain districts), blue grouse, Franklin grouse, ptarmigan.....	Sept. 15-Dec. 1.
Prairie chicken (certain districts).....	Sept. 15-Oct. 16.
Quail and male pheasants (certain districts).....	Oct. 1-Dec. 16.
Rail, coot, plover, snipe, curlew, sandpiper, crane, duck (see exception).....	Sept. 1-Feb. 1.
Exception: In Alberni, Comox, Cowichan, Esquimalt, Islands, Nanaimo, Newcastle, and Saanich Electoral Districts.....	Sept. 15-Feb. 16.
Goose (see exception).....	Sept. 1-Apr. 1.
Exception: In Chilliwack, Delta, and Richmond Districts.....	Sept. 1-Mar. 1.
No open season: Buffalo, elk, young of deer and goat, and females and young of moose, caribou, and sheep.	

Manitoba:⁵

Deer, elk or wapiti, moose, caribou or reindeer, antelope or cabri (males).....	Dec. 1-Dec. 15.
Partridge, prairie chicken, grouse, ptarmigan.....	Oct. 1-Oct. 20.
Woodcock, plover, sandpiper, snipe, duck.....	Sept. 15-Dec. 1.
No open season: Bison or buffalo, females and young of big game, dove; quail, pheasant, curlew (1920).	

New Brunswick:

Deer, moose, caribou (cow and calf ⁶ moose and caribou, no open season).....	Sept. 15-Dec. 1.
Partridge, woodcock, snipe.....	Sept. 15-Dec. 1.
Teal, wood duck, dusky or black duck (except residents may kill black ducks in Grand Manan Parish, Oct. 1-Mar. 1), goose, brant.....	Sept. 1-Dec. 2.
Shore or other birds on beaches, islands, or lagoons bordering tidal waters of Northumberland Strait, Gulf of St. Lawrence, and Bay of Chaleur.....	Aug. 15-Jan. 1.
No open season: Pheasant.	

Newfoundland:⁷

Caribou (except in a special region near Grand Lake, no open season).....	Oct. 21-Feb. 1. ⁸
Hare, rabbit.....	Sept. 20-Jan. 1.
Ptarmigan, willow grouse or partridge, plover, curlew, snipe, or "other wild or migratory birds (except wild geese)".....	Sept. 20-Jan. 1.
No open season: Elk, moose; capercaillie, black game (1917).	

¹ Wyoming: During the season of 1915 fifty (50) bull moose may be killed under special \$100 license; hunter to be accompanied by deputy warden.

² Alberta: North of latitude 55° any game animal or bird, except elk and buffalo, may be killed at any time if needed for food.

³ Except white-winged scoters, north of township 50, which may be taken at any time.

⁴ British Columbia: For local exceptions, see regulations of lieutenant governor in council. No open season on deer in Queen Charlotte Islands or on white-tailed deer in Okanogan and Similkameen Electoral Districts.

⁵ Manitoba: Seasons apply south of latitude 53°; north, unlawful to kill any game birds (except ducks and geese) or any big game animals, except for food for personal use.

⁶ New Brunswick: Under three years of age and with horns having less than three times 4 inches in length.

⁷ Newfoundland: Poor settlers may kill any birds except capercaillie and black game at any time for immediate consumption by themselves or their families.

⁸ Additional open season Aug. 1-Oct. 1.

Open seasons for game—Continued.

Nova Scotia:

	<i>Open seasons.</i>
Moose, bulls (except on Cape Breton Island, 1918).....	Sept. 16-Nov. 30.
Caribou, bulls, in Inverness and Victoria Counties only.....	Sept. 16-Oct. 16.
Hare, rabbit.....	Oct. 1-Mar. 1.
Quail, plover, curlew, sandpiper, tattler, shore bird, rail, coot, teal, swan.....	Aug. 15-Jan. 1.
Ruffed grouse or birch partridge.....	Oct. 1-Nov. 1.
Woodcock, Wilson snipe.....	Sept. 1-Jan. 1.
Duck, geese, brant.....	Sept. 15-Mar. 1.
<i>No open season:</i> Caribou (except as above), deer, cow moose (1918); Canada grouse (spruce partridge), pheasant, wood duck.	

Ontario:¹

Deer (except in Dufferin, Grey, Simcoe, and Wellington Counties, to Nov. 1, 1917; in Bruce County, Nov. 1, 1916).....	Nov. 1-Nov. 16. ²
Moose, caribou (bulls only) (cows, and calves under 1 year of age, no open season).....	Oct. 16-Nov. 16. ³
Hare ⁴	Oct. 1-Dec. 16.
Squirrel (black or gray) (see exceptions).....	Nov. 15-Dec. 2.
<i>Exceptions:</i> Haldimand and Halton Counties..... Oct. 14, 1917.	
Wild turkey.....	Nov. 15-Dec. 2.
Partridge, grouse (except in Haldimand and Halton Counties, 1917), prairie fowl.....	Oct. 15-Nov. 16.
Capercaillie.....	Sept. 15-Dec. 16.
Woodcock.....	Oct. 1-Nov. 16.
Swan, goose.....	Sept. 15-Apr. 16.
Plover, snipe, rail, other shore birds, duck and other waterfowl.....	Sept. 1-Dec. 16. ⁵
<i>No open season:</i> Fawns, elk or wapiti, dove; quail, Hungarian partridge, pheasants (1916). ⁶	

Prince Edward Island:

Hare, rabbit.....	Nov. 1-Feb. 1.
Partridge (alternate years, 1915, 1917, etc.).....	Oct. 15-Nov. 15.
Plover, curlew.....	Aug. 1-Jan. 1.
Snipe, woodcock.....	Sept. 1-Jan. 1.
Yellowlegs, shore and other birds along beaches or tidal marshes, duck.....	Aug. 20-Jan. 1.
Goose.....	Sept. 15-May 10.
Brant.....	Apr. 20-Jan. 1.

Quebec:

Zone 1.¹

Deer, bull moose (see exception).....	Sept. 1-Jan. 1.
<i>Exception:</i> In Labelle, Ottawa, Pontiac, and Temiscaming Counties..... Oct. 1-Dec. 1.	
Caribou.....	Sept. 1-Feb. 1.
Hare.....	Oct. 15-Feb. 1.
Bear.....	Aug. 20-July 1.
Birch or swamp partridge.....	Sept. 1-Dec. 15.
White partridge or ptarmigan.....	Nov. 1-Feb. 1.
Woodcock, plover, curlew, tattler, sandpiper, snipe.....	Sept. 1-Feb. 1.
Widgeon, teal, duck (except sheldrake), gull, loon.....	Sept. 1-Mar. 1. ²
<i>No open season:</i> Cow moose and young deer, moose and caribou.	

Zone 2. Seasons same as in Zone 1, except as follows:

Caribou.....	Sept. 1-Mar. 1.
Hare.....	Oct. 15-Mar. 1.
Birch or swamp partridge.....	Sept. 15-Feb. 1.
White partridge or ptarmigan.....	Nov. 15-Mar. 1.

¹ *Ontario:* Lieutenant governor in council may alter close seasons in region north and west of French River, Lake Nipissing, and Mattawa River and in the vicinity of Rondeau Park, and close for a definite period seasons for any game animal or nonmigratory game bird whose numbers have diminished.

² Persons who put deer on their own lands, and their licensees, may hunt such deer, Oct. 1-Nov. 16.

³ South of the Canadian Pacific R. R., between Mattawa and the Manitoba boundary, Nov. 1-16.

⁴ Cottontail rabbits (wood hares) may be killed during close season when damaging trees or shrubs, and from Dec. 15-Jan. 1, otherwise than by shooting.

⁵ Shore birds and waterfowl south of the Canadian Pacific, between Montreal and Toronto, and the Guelph and Goderich Railways, Sept. 15-Dec. 16.

⁶ Under act for protection of insectivorous birds, Rev. Sts., 1897, ch. 289, sec. 3.

⁷ *Quebec:* Zone No. 1 comprises the whole Province, except that part of the counties of Chicoutimi and Saguenay east and north of the River Saguenay. Zone No. 2 comprises the excepted part of said counties.

⁸ Inhabitants of Zone 2 and Gaspé County may take these birds for food Aug. 1-June 1.

Open seasons for game—Continued.

Saskatchewan: ¹		<i>Open seasons.</i>
Deer, elk or wapiti, moose, caribou (males only).....		Nov. 15–Dec. 1. ²
Partridge, prairie chicken, grouse, ptarmigan.....		Sept. 15–Nov. 16
Plover, curlew, sandpiper, snipe, shore birds, coot, rail, duck, goose, swan, crane (except whooping crane).....		Sept. 15–Jan. 1.
<i>No open season:</i> Antelope, buffalo, and females and young of other big game, English pheasant, whooping crane.		
Northwest Territories: ³		
Deer, elk or wapiti, moose, caribou, goat, sheep.....		Dec. 1–Apr. 1. ⁴
Musk ox.....		Oct. 15–Mar. 20.
Partridge, prairie chicken, grouse, pheasant.....		Sept. 1–Jan. 1.
Duck, goose, swan.....		Sept. 1–Jan. 15.
Yukon: ⁵		
Deer, elk or wapiti, moose, caribou, sheep, goat, musk ox (males only).....		Sept. 1–Mar. 1.
Partridge, prairie chicken, grouse, ptarmigan, pheasant.....		Sept. 1–Mar. 15.
Sandpiper, snipe, crane, duck, goose, swan.....		Aug. 10–June 1.
<i>No open season:</i> Bison or buffalo and females of other big game.		

SHIPMENT OF GAME.

Shipment is the most important feature of the traffic in game. If permitted without limitation it is a great factor in game destruction. A realization of this fact has induced many of the States to prohibit export of all or certain kinds of game, and in a few instances all transportation even within the State. The subject may be conveniently considered under the following subheads: "Federal laws" and "State laws prohibiting export."

FEDERAL LAWS.

Federal laws affecting the shipment of game comprise the statutes regulating interstate commerce in game and the importation of birds from foreign countries, and those providing for the protection of birds and game on territory under immediate Federal jurisdiction.

They comprise: (1) Sections 241 to 244 of the Criminal Code (35 Stat., 1137), regulating the importation and interstate shipment of game;⁶ (2) the tariff act, imposing duties on game and skins and prohibiting the entry of feathers imported from foreign countries; (3) the act regulating the introduction of eggs of game birds; (4) the game law of Alaska; and (5) provisions for protecting birds in national parks,⁷ national forests, and other Government reservations. The full text of the Alaskan game law of 1908, with the regula-

¹ *Saskatchewan:* Lieutenant governor in council may extend close seasons over current year, within limits, on petition of six game guardians.

² Applies north of line between townships 34 and 35; south of said line, no open season.

³ *Northwest Territories:* Indians, inhabitants, travelers, explorers, and surveyors in need of food, exempt. Governor in council may alter seasons.

⁴ Also July 15–Oct. 1.

⁵ *Yukon:* Indians, explorers, surveyors, prospectors, miners, and travelers in need of food are exempt. Commissioner in council may alter seasons.

⁶ *Federal laws:* These sections are sections 2, 3, and 4 of the Lacey Act as amended.

⁷ The law governing the Yellowstone Park prohibits any person, or any stage, express, or railway company from receiving for transportation animals, birds, or fish taken in the park, under a penalty not exceeding \$300. (28 Stat., ch. 72, sec. 4.)

tions now in force, is published in circulars of the Biological Survey. Sections 241, 242, 243, and 244 of the Criminal Code of the United States are as follows:

SEC. 241. The importation into the United States, or any Territory or District thereof, of the mongoose, the so-called "flying foxes" or fruit bats, the English sparrow, the starling, and such other birds and animals as the Secretary of Agriculture may from time to time declare to be injurious to the interests of agriculture or horticulture, is hereby prohibited; and all such birds and animals shall, upon arrival at any port of the United States, be destroyed or returned at the expense of the owner. No person shall import into the United States or into any Territory or District thereof any foreign wild animal or bird, except under special permit from the Secretary of Agriculture: *Provided*, That nothing in this section shall restrict the importation of natural-history specimens for museums or scientific collections, or of certain cage birds, such as domesticated canaries, parrots, or such other birds as the Secretary of Agriculture may designate. The Secretary of the Treasury is hereby authorized to make regulations for carrying into effect the provisions of this section.

SEC. 242. It shall be unlawful for any person to deliver to any common carrier for transportation, or for any common carrier to transport from any State, Territory, or District of the United States, to any other State, Territory, or District thereof, any foreign animals or birds, the importation of which is prohibited, or the dead bodies or parts thereof of any wild animals or birds, where such animals or birds have been killed or shipped in violation of the laws of the State, Territory, or District in which the same were killed, or from which they were shipped: *Provided*, That nothing herein shall prevent the transportation of any dead birds or animals killed during the season when the same may be lawfully captured, and the export of which is not prohibited by law in the State, Territory, or District in which the same are captured or killed: *Provided further*, That nothing herein shall prevent the importation, transportation, or sale of birds or bird plumage manufactured from the feathers of barnyard fowls.

SEC. 243. All packages containing the dead bodies, or the plumage, or parts thereof, of game animals, or game or other wild birds, when shipped in interstate or foreign commerce, shall be plainly and clearly marked, so that the name and address of the shipper, and the nature of the contents, may be readily ascertained on an inspection of the outside of such package.

SEC. 244. For each evasion or violation of any provision of the three sections last preceding, the shipper shall be fined not more than two hundred dollars; the consignee knowingly receiving such articles so shipped and transported in violation of said sections shall be fined not more than two hundred dollars; and the carrier knowingly carrying or transporting the same in violation of said sections shall be fined not more than two hundred dollars.

STATE LAWS PROHIBITING EXPORT.

Since the constitutionality of the Connecticut statute prohibiting export of certain game was established by the supreme court in 1896,¹ nonexport laws have been generally adopted, and at the present time every State prohibits the export of all or certain kinds of game. In most States sportsmen are allowed to carry a limited quantity of game out of the State under special restrictions, and exceptions to the laws prohibiting export are also made in the case of birds and animals intended for propagation or reared in licensed preserves (see pp. 49-51).

¹ Geer v. Conn., 161 U. S., 519.

Restrictions on shipment from the State have now become so stringent that all the States west of the Mississippi River prohibit export of all game protected by local laws. East of the Mississippi, laws prohibiting the export of all game, or, in some cases, all but one or two unimportant species, are in force in all the States except Kentucky and a small group along the coast from Massachusetts to North Carolina.

Special attention is called to the following table, which contains a list of the game prohibited from export by each State:

EXPORT OF GAME PROHIBITED.

Alabama: All protected game.

Exceptions: Nonresident licensee may take with him or have carried to him, openly, game lawfully killed by him. State game and fish commissioner may issue \$1 permit to any person to capture or export not more than 10 pairs of any one species of game or birds for scientific or propagating purposes.

Alaska: Deer, moose, caribou, sheep, goat, bear, or hides of these animals; wild birds, except eagles, or any parts thereof.

Exceptions: Specimens may be exported under restrictions imposed by the Secretary of Agriculture and trophies of big game under licenses issued by the governor.¹

Arizona: All protected game.

Exceptions: Deer or wild turkey may be exported under a \$2 permit. Game may be exported under permit of warden for scientific or propagation purposes.

Arkansas: All protected game (except rabbits, which must be shipped open to view).

California: All protected game.

Colorado: All protected game.

Exceptions: Game may be exported under permit from game commissioner if permit be attached and package plainly marked so as to show nature of contents. The following fees are charged for export permits: Elk, \$10; deer, \$5; sheep, \$5; bird, 25 cents—in each case the edible portion alone.

Connecticut: Quail, ruffed grouse, woodcock.

Exception: Nonresident licensee, under permit, may take out in his immediate possession game lawfully killed, when duly tagged, if not for sale.

Delaware: Rabbit, quail, partridge, woodcock. Squirrel, dove, rail, reedbird, goose, brant, for sale.

Exception: Holder of license may export 10 rabbits, 10 squirrels, 50 reedbirds, 50 rail, and 20 birds or fowl of any other species a week, lawfully killed by himself, under affidavit that the game is not for sale.

Florida: All protected game.

Exception: Nonresident licensee may carry out game as personal baggage.

Georgia: All protected game from county or State.

Exception: Licensee may take out in personal possession game lawfully killed.

Idaho: All protected game.

Exceptions: Any hunter may export, under hunting license, big game lawfully taken, under a 50-cent permit obtained from game warden or a deputy game warden on a sworn statement to issuing officer that game was not procured contrary to law. Mounted heads and stuffed birds legally secured may be exported.

Illinois: All protected game (except rabbits taken in State).

Exceptions: Nonresident licensee may take from State 50 birds killed by himself, if carried openly for inspection. Holder of certificate may ship birds and game at any time for scientific or propagation purposes.

Indiana: Deer, quail, grouse, prairie chicken, pheasant, wild turkey, woodcock, duck, goose, brant, and other waterfowl.

Exception: Nonresident may take from State 15 birds killed by himself (or 45 if he has hunted for 3 or more days consecutively) if carried openly for inspection together with license.

Iowa: All protected game.

Exception: Nonresident may take from State not more than 25 game birds or animals, if carried openly for inspection, and if hunting license be shown on request.

Kansas: All protected game.

Kentucky: Quail, partridge, grouse, pheasant, wild turkey killed in the State.

¹ *Alaska.* See p. 57 and also circulars of the Biological Survey, U. S. Department of Agriculture.

*Export of game prohibited—Continued.***Louisiana:** All protected game.

Exceptions: A nonresident licensee may carry with him out of the State, under his license, one day's bag limit of game, if not for sale. Game for propagation, head, hide, feet of quadrupeds, and the plumage or skins of birds legally taken when properly marked. Bears may be exported under permit.

Maine: All protected game.

Exceptions: A resident of the State may export 1 deer a season if open to view, tagged to show name and address of owner and accompanied by him, and under shipping license 5 partridges, 10 woodcock, and 10 ducks (fee \$5), lawfully killed by himself. A nonresident may export under hunting license tags 2 deer lawfully killed by himself and may take home 5 partridges, 10 ducks, and 10 woodcock; he may also ship out one pair of game birds a month under a special 50-cent license. Live game may be exported for breeding, scientific, or advertising purposes, under permit of the commissioners of inland fisheries and game.

Maryland—County provisions, as follows:

Allegany—Deer, squirrel, rabbit, partridge or quail, pheasant, English pheasant, turkey, dove, woodcock from county (for sale).

Anne Arundel—All protected game, viz: Squirrel, rabbit, quail, partridge, pheasant, woodcock, snipe, plover, duck, goose, brant from county.

Baltimore—Rabbit, squirrel, quail, partridge, pheasant, dove, woodcock from county.

Calvert—Rabbit, partridge, woodcock from county (for sale, barter, or trade).

Carroll—Squirrel, quail, pheasant, dove, woodcock.

Exception: Twelve squirrels, 10 quail, 3 pheasants, 12 doves, 6 woodcock, by guest of landowner or nonresident licensee as personal baggage and not for sale.

Caroline—Rabbit, quail, partridge, woodcock from county.

Cecil—Squirrel, quail, grouse, woodcock, plover from county.

Dorchester—All protected game.

Exception: Twelve quail or partridges, 6 each of squirrels, rabbits, woodcock, and doves may be taken out of the county at one time as personal baggage, if carried openly and not intended for sale.

Frederick—Squirrel, partridge, pheasant, woodcock, from county (for sale).

Garrett—Partridge, pheasant, wild turkey, woodcock from State.

Exceptions: Rabbit, if shipped openly, Nov. 10-Dec. 25. Nonresident may take out game killed under his hunting license.

Harford—All protected game.

Exception: Nonresident licensee may take out 6 rabbits, 1 jack rabbit, 8 squirrels, 10 quail, 5 woodcock, 10 jacksnipe, 50 rail for private use.

Kent—Squirrel, rabbit, and all birds from county (for sale, except under license).

Montgomery—Rabbit, partridge, quail, woodcock from county (for sale).

Exception: Nonresident licensee may take out game lawfully killed.

Queen Anne—Rabbit, partridge, woodcock from county (for sale).

Somerset—All game, viz: Squirrel, rabbit, quail or partridge, pheasant, dove, woodcock, duck, goose from county.

Talbot—All game.

Exception: Six rabbits, 6 squirrels, 12 quail, 6 doves, 6 woodcock may be taken out if not for sale.

Washington—Deer, squirrel, rabbit, partridge, pheasant, dove, woodcock, turkey from county (for sale).

Wicomico—Quail or partridge from Wicomico and Worcester Counties considered as one territory.

Worcester—Rabbit, quail, woodcock from county.

Massachusetts: Quail, ruffed grouse, woodcock taken in State; other game illegally taken in State.

Exception: Nonresident may take 10 wild fowl or birds of all kinds out of the State under his hunting license.

Michigan: All protected game.

Exceptions: (1) Deer may be transported outside the State to reach a point within the State.

(2) Nonresident licensee may take out, as hand baggage, 1 day's bag limit of birds, and may ship 1 deer when license tag and seal is attached, if permit on back of license coupon is canceled by agent at initial point of billing.

(3) Landowners and members of clubs owning game preserves may take out as hand baggage during open season under a \$10 permit from State warden 20 ducks or other migratory birds killed by them on their own premises.

(4) Deerskins and green or mounted buck-deer heads may be exported under permit.

Minnesota: All protected game.

Exceptions: Nonresident licensee may ship home in open season under his license coupons 1 deer and 25 birds lawfully taken by himself. Deer and moose hides for tanning and moose heads for mounting may be exported under permit.

Mississippi: All protected game.

Export of game prohibited—Continued.

Missouri: All protected game.

Exceptions: Game may be exported under resident or nonresident license if carried openly as baggage or express or in owner's possession and accompanied by him. Export (except of quail) for scientific or propagating purposes allowed under permit.

Montana: All protected game.

Exception: Game lawfully killed may be exported in open season as baggage or express if accompanied by owner and resident's shipping permit (fee 50 cents) from State warden, or nonresident's hunting license; total shipment under one license not to exceed season's bag limit; packages to be labeled to show contents.

Nebraska: All protected game.

Exception: Nonresident may ship 50 birds out of State under hunting license, but must give common carrier invoice of number and kind of birds, must have details of shipment marked on license, and must accompany the shipment.

Nevada: All protected game.

New Hampshire: All protected game.

Exceptions: Game (except ruffed grouse) imported from without the United States or raised in private preserves when tagged and marked to show kind and number, name and address of consignor and consignee, and initial point of billing and destination may be exported unaccompanied by the owner. Game for propagation, the head, hide, feet, or fur of game quadrupeds, and the plumage or skin of game birds legally taken and possessed may be exported without being marked. Nonresident may take out of the State under his hunting license and permit one day's limit of game when properly marked and tagged.

New Jersey: Hare, rabbit, squirrel, woodcock, waterfowl, and all protected game birds.

Exceptions: Nonresident licensee may carry openly from the State 10 rabbits, 50 reed birds, 50 rail, and 15 other game birds a day.

New Mexico: Export of all game taken in the State.

Exceptions: Transportation of game permitted under license coupon or 25 cent permit (\$2 in case of export of deer); holder of hunting license, under permit from warden, may export game or birds for scientific or propagation purposes.

New York: Game or birds taken in the State.

Exceptions: Holder of hunting or trapping license may export daily limit of quadrupeds and birds under permit (limited to 6 permits a year). Foreign game or game raised in licensed preserves may be exported in any quantity when duly marked and tagged. Game for propagation and heads and skins of quadrupeds and game birds legally captured may be exported.

North Carolina:¹ Quail, partridge, pheasant, grouse, wild turkey, snipe, shore or beach bird, woodcock, taken in State.

Exceptions: Nonresident may take out of State under his hunting license 50 quail (partridges), 12 grouse, 2 turkeys, and 50 beach birds or snipe in a season. Export permitted under permit of Audubon Society of ruffed grouse, wild turkey, woodcock, snipe, and other shore birds, for propagation.

North Dakota: All protected game.

Exceptions: Nonresident licensee may carry with him from State under license tag prairie chickens and sharp-tailed grouse not exceeding 20 in all, and ducks, geese, and brant not exceeding 30 in all, or a total of 50 of all birds combined, if open to view and labeled with his name and address and number of his license. Game may be exported for propagation or scientific purposes.

Ohio: All protected game except rabbits taken in State.

Exception: Nonresident may take with him from State under his hunting license 25 pieces of game.

¹*North Carolina:* Export is also prohibited by the following local laws (from county unless otherwise stated): *Deer*, Cherokee, Craven, Hyde (Currituck Twp.); *squirrel*, Craven, Madison, Warren; *quail*, Alamance, and Alexander (for sale), nonresident licensee may export 50 at a time; Anson (for sale), Avery, Bladen (for sale), Catawba, Chatham (for sale), Cherokee, Clay, 25 a season may be exported, Cleveland (to Mar. 7, 1916), Craven, Cumberland, Davidson (for sale), Davie (for sale), Duplin (for sale), Guilford (for sale), Harnett, Henderson (bought or sold), Hoke, Iredell, Jackson, Macon (for sale), Madison, Montgomery (for sale), Pitt, Randolph (for sale), Robeson, Rutherford, Sampson (for sale), Stanly, Surry (for sale), Swain (live), Union (for sale), Warren, nonresident licensee may export 25 quail and 1 turkey a season; Wayne, Wilson, nonresident may take out quail killed on own land if not for sale; Yadkin (for sale); *wild fowl*, Avery, Craven (from State), Brunswick (Mar. 10-Nov. 10), Dare (Mar. 10-Nov. 10), New Hanover (Mar. 10-Nov. 10), Robeson, Stanly, Warren (duck); *other game birds*, Bladen (wild turkey, for sale); Cherokee (pheasant, dove, woodcock, snipe, robin); Craven (wild turkey, dove, woodcock, snipe); Cumberland (woodcock, snipe); Madison (pheasant), Montgomery (pheasant, grouse, wild turkey, dove, for sale); Robeson (dove, woodcock, snipe); Stanly (all game birds), Tyrrell (woodcock, snipe, from State, unless killed Nov. 1-Feb. 1); Union (dove, lark, for sale); Warren (wild turkey, except one a season may be exported by nonresident licensee, woodcock); Wayne (woodcock, snipe).

Export of game prohibited—Continued.

Oklahoma: All protected game.

Exception: Nonresident licensee may carry to his home two days' bag limit of game birds.

Oregon: All protected game.

Pennsylvania: All protected game taken in the State.

Exception: Nonresident licensee may take with him from the State one day's bag labeled with his name and address and number of his license.

Rhode Island: All protected game birds.

Exception: Nonresident may take with him from the State under his hunting license, open to view, 10 wild fowl or birds the export of which is otherwise prohibited by law.

South Carolina: All game birds or animals taken in the State.

Exception: Licensee may carry openly 2 deer, or 50 partridges, or 12 ruffed grouse, or 4 wild turkeys, or 50 beach birds, or 50 ducks and geese in a season.

South Dakota: All protected game.

Exceptions: One deer under permit and proper tag. Any resident or nonresident may carry out of the State any game bird legally in possession.

Tennessee: All protected game.

Exception: Licensee may take out under his license game killed in State, if carried openly.

Texas: All wild animals, wild birds, and wild fowl found in the State.

Exception: Nonresident licensee may take with him from the State 3 male deer, 75 ducks (if killed in three consecutive days by himself), and one day's bag limit of other birds, under affidavit that his game will not be sold.

Utah: All protected game.

Exception: Nonresident licensee may take one day's bag out of State under permit.

Vermont: Deer, gray squirrel, quail, ruffed grouse or partridge, plover, English snipe, woodcock, duck, goose.

Exceptions: Nonresident licensee may export 1 deer and one day's bag of game birds under permit, but must accompany shipment. Resident may send out as a gift one day's limit of game or game birds under special permit from commissioner, but not for sale or barter.

Virginia: All protected game except waterfowl legally killed.

Exceptions: During open season nonresident may, under his hunting license, take with him out of the State, or as baggage on the same conveyance, 1 deer, 50 quail or partridges, 10 pheasants or grouse, 3 wild turkeys, and 25 of each or 100 in all of plover, snipe, sandpipers, willets, tattlers, and curlew, if killed or captured by himself and shipped open to view and plainly labeled with his name and address. Back Bay, Princess Anne County, nonresident licensee permitted to export as personal baggage, 25 ducks, geese, or brant, he has lawfully killed, but not for sale or barter. Any citizen of State may ship from the State, as a gift and not for sale (which fact must be stated on shipping tag), 1 deer, 18 quail or partridges, 6 pheasants, 3 wild turkeys, if open to view and plainly labeled with names and addresses of donor and donee, and number of each kind of bird so shipped.

Washington: All protected game.

West Virginia: Deer, squirrel, quail, ruffed grouse (pheasant), wild turkey, woodcock, plover, snipe, sandpiper, duck, goose, brant, swan.

Wisconsin: All protected game, except rabbit and squirrel.

Exceptions: Nonresident may take out of State with him under his hunting license, in personal possession or as baggage or express, not more than 30 birds of all kinds, provided packages are plainly marked so as to show the names and addresses of shipper and consignee and number of each kind of game. In the case of deer, he must have proper coupons attached. Park boards allowed to ship, under permit of State game warden, live animals and game birds for park purposes.

Wyoming: All protected game.

Exceptions: Smithsonian Institution or other well-known scientific institutions may export any game animals or birds under permit of State game commission.

Export of game legally taken permitted upon affidavit that they were taken from animals lawfully killed, the payment of 25 cents to the justice of the peace of precinct where affiant lives, and attachment of the tag issued by him if edible portion is not for sale; a nonresident (or resident when necessary to cross territory of another State to reach his home) may export under his hunting license 20 dead game birds and the carcass, head, antlers, scalp, skin, and teeth of any animal lawfully killed, when duly tagged; exchange of game animals and birds for liberation in Wyoming allowed under permit of the State game commission.

Alberta: All protected game.

Exceptions: Minister of agriculture, on receipt of \$5 fee, may grant a permit to export for propagation or scientific purposes one pair of each species of big game and game birds. The lieutenant governor in council may grant permits for a greater number. The minister of agriculture may also issue permits for export of game for other purposes at the rate of \$5 for each head of big game and \$1 per dozen for game birds. The holder of a general nonresident license may take with him out of the Province as trophies heads, skins, and hoofs of big game legally killed by him. Any person may export mounted or branded heads at a fee of \$1 for each head.

Export of game prohibited—Continued.

British Columbia: All protected game, except under permit of provincial game warden.

Exceptions: Heads, horns, and skins of big game lawfully killed by the shipper may be shipped under his hunting license and written permission of minister charged with enforcement of act. Any animal or bird, dead or alive, may be exported for scientific, zoological, or Government purposes under permit of provincial secretary. Live game birds or animals held in captivity under written permission of provincial game warden may be exported.

Manitoba: All protected game.

Exceptions: Minister of agriculture and immigration may direct chief game guardian to export not more than 12 animals or birds for propagation and may issue permits to export heads and skins of big game animals and any game birds (fee \$1), except grouse, ptarmigan, prairie chicken, and partridge, but not more than 100 geese and swans or 50 ducks, and these only under nonresident license. (No export of ducks permitted before October 1.) The following export fees are charged: Deer or deer head, \$2 each; head or carcass of elk, moose, or caribou, \$5 each; any hide, 25 cents. No export fee required of nonresident licensee.

New Brunswick:¹ All protected game.

Exception: Surveyor general may issue special license to export game alive or dead.

Newfoundland: Caribou (antlers, heads, or skins), or partridge, willow or other grouse for sale.

Exceptions: Minister of marine and fisheries may issue licenses to export caribou for breeding or scientific purposes. Nonresident may export 3 stag caribou under hunting license and export permit (fee, 50 cents); resident may export antlers, head, or skin of caribou under export permit; but not, in either case, for sale.

Nova Scotia: All protected game.

Exceptions: Holder of general license may ship out of Province 1 moose lawfully shot by himself. Mounted heads and dressed skins and live mammals or birds for propagation or scientific purposes may be exported under permit from provincial secretary.

Ontario: All wild game animals and birds.

Exceptions: One deer, 1 bull moose, 1 bull caribou, and 100 ducks may be exported under nonresident hunting license if shipping coupon and, if required, affidavit of lawful killing be attached and contents of packages be open to view. Lawfully imported game and deer, moose, elk, or caribou held by private ownership may be exported.

Prince Edward Island: All game except geese and brant.

Exception: Nonresident licensee may carry out of Province 12 birds killed by himself.

Quebec: Native deer, moose, caribou, or parts thereof, except under permit from minister of colonization mines, and fisheries (fee not to exceed \$5); also under tags attached to nonresident licenses, not later than 15 days after close of season.

Saskatchewan: All protected game.

Exceptions: Minister of agriculture may grant permits to export for scientific purposes or propagation in public parks and zoological gardens 1 pair of each species of big game and game birds upon payment of \$5, or for propagation a specified number on application of another Province or State. Minister may issue permits to export big game (fee \$5 per head), birds (except grouse family) (fee \$1 per dozen, limit 5 dozen per season). Nonresident licensee may export under his license and permit big game and 100 game birds legally killed.

Yukon: Protected game may be exported by a nonresident only under a hunting license and a shipping permit issued by the commissioner of the Territory or a game guardian. Export permitted of one head of each of the following kinds of big game: Moose, caribou, sheep, and goat.

Canada also has a general law prohibiting export of deer (except those raised on private preserves), wild turkeys, quail, partridges, prairie fowl, and woodcock, but permitting each nonresident to export two deer² in a year at certain ports within 15 days after the close of the open season, under permit of the collector of customs of the port from which export is made. The ports of export are: Halifax and Yarmouth, Nova Scotia; Macadam Junction, New Brunswick; Quebec and Montreal, Quebec; Ottawa, Kingston, Niagara Falls, Fort Erie, Windsor, Sault Ste. Marie, and Port Arthur, Ontario; and such others as the minister of customs may designate.

¹ *New Brunswick:* Except in the case of partridge, the prohibition applies only to common carriers.

² Except from Ontario (see above).

Those who visit Canada to hunt, camp, etc., must deposit with the customs officer at the port of entry an amount equal to the duty (30 per cent of appraised value) on their guns, canoes, tents, cooking utensils, and kodaks. If these articles are taken out within six months at the same port, the deposit will be returned. But members of shooting or fishing clubs that own preserves in Canada and have filed a guaranty with the Canadian commissioner of customs may present club membership certificates in lieu of making the deposit. They must, however, pay duty on all ammunition and provisions.

SALE OF GAME.

Legislation restricting the sale of game is passing through a transition stage. Some States prohibit the sale of game throughout the year, others only in close season, and between these extremes may be found all gradations and exceptions, such as restrictions prohibiting sale of game outside the State or for export, and exemptions allowing sale for a few days in the close season. The difficulty of tabulating such regulations is increased by the fact that in addition to the special sale laws, close seasons and provisions regarding possession must be taken into consideration. In consulting the following summary, therefore, it will be necessary to bear in mind three different classes of restrictions: "Sale in close season," "Sale in open season," and "Sale prohibited all the year."

SALE IN CLOSE SEASON.

In general, the sale of game is prohibited during the close season, but a brief additional open period is sometimes provided in order to permit dealers to close out stock on hand at the end of the hunting season. An extension of 10 days for sale of all or certain kinds of game is added to the open season in New Brunswick; 15 days in Alaska, New Jersey, and Quebec; 30 days in Pennsylvania; 60 days in Yukon; 3 months (for geese and brant) in New Brunswick; and until the following 1st of January in Ontario. In New Hampshire and Vermont the sale of deer meat is permitted for a reasonable time after the close of the season.

SALE IN OPEN SEASON.

In order to counteract a tendency on the part of market hunters to anticipate the opening of the season, the sale of certain game is sometimes prohibited at the beginning of the open season, as during the first three days in Nova Scotia and Quebec, the first month in British Columbia, and the first six weeks in Louisiana.

SALE PROHIBITED ALL THE YEAR.

Forty-seven States ¹ and most of the Provinces of Canada now prohibit the sale of all or certain kinds of game at all seasons. In Alabama, Arizona, Colorado, Florida, Georgia, Idaho, Iowa, Kansas, Minnesota, Mississippi, Missouri, Montana, Nebraska, Nevada, New Mexico, North Dakota, Oklahoma, South Dakota, Tennessee, Texas, and Washington, the sale, and in Delaware, the resale, of all protected game is prohibited; in Illinois, Massachusetts, Michigan, New York, Ohio, West Virginia, and Wisconsin, except rabbits or a few unimportant species; and in Utah and Manitoba of all big game and upland game. In a few instances prohibitions against the sale of certain game are so general as to afford protection over a considerable area in adjoining States. Thus, ruffed grouse may not be sold in any State or Province along the Canadian border except Quebec. Practically every State in which prairie chickens occur now prohibits their sale or export.

The following statement shows the kind of game the sale of which is prohibited throughout the year. The sale of all other game is so generally prohibited during the close season as to render a detailed enumeration unnecessary; but when an extension of a few days is added to the open season or a special season is provided for either possession or sale, attention is called to this exemption under the heading "Permitted":

SALE OF GAME PROHIBITED THROUGHOUT THE YEAR.

Alabama: All protected game.

Alaska: Heads, hides, and skins of all protected game. Deer until August 1, 1916.

Permitted: Carcasses of all game except deer may be sold during the open season and 15 days thereafter.

Arizona: All protected game.

Arkansas: All "game, wild fowl, or birds whatsoever," except bear, rabbit, opossum, raccoon, and squirrel.

California: Deer meat and hides and all other protected game (except cottontail and bush rabbits, duck, goose, and black brant).

Colorado: All game taken in the State.

Permitted: Imported game (under license).

Connecticut: Quail, ruffed grouse, Hungarian partridge, woodcock.

Delaware: All protected game, except that a resident lawfully taking game may sell plover, snipe, and ducks anywhere, and other game in his own county; restaurants buying from such persons may serve game in open season.

Florida: All protected game.

Georgia: All protected game.

Idaho: All protected game.

Illinois: All protected game (except rabbit during open season).

Indiana: Quail, prairie chicken, imported pheasants, Hungarian partridge.

Iowa: All protected game.

Kansas: All protected game.

Kentucky: Quail, partridge, grouse, pheasant, wild turkey, killed in the State.

¹ Omitting Alaska, which prohibits sale only of heads, skins, and trophies and deer in southeastern Alaska until Aug. 1, 1916; District of Columbia, which prohibits sale only in close season; and North Carolina, which prohibits sale in only a few counties.

Sale of game prohibited throughout the year—Continued.

Louisiana: All protected game (except snipe, rail, coots, poule d'eau, duck, goose, and brant, which may be sold from December 15 to February 15).

Maine: Deer or moose for export. All protected game birds for any purpose.

Permitted: Deer may be sold by local dealers under license.

Maryland:

Allegany—Deer, quail, grouse, English pheasant, wild turkey, dove, woodcock.

Anne Arundel—All game except squirrel, rabbit, and raccoon.

Baltimore—Rabbit, squirrel, quail, ruffed grouse, dove, pheasant, woodcock, for export.

Calvert—Rabbit, quail, woodcock, for export for sale.

Carroll—Squirrel, partridge, pheasant, dove, woodcock.

Cecil—Squirrel, quail, grouse, woodcock, plover.

Dorchester—Rabbit, squirrel, quail, partridge, dove, woodcock, wood duck, for export.

Frederick—Squirrel, partridge, pheasant, woodcock, taken in county.

Garrett—Partridge, quail, pheasant, wild turkey, woodcock, for export.

Harford—All game.

Montgomery—Rabbit, quail, partridge, woodcock, for export.

Somerset—Rabbit, quail or partridge, woodcock, dead or alive, for any other purpose than as food within the county or for propagation; or any game for export.

Washington—All game.

Wicomico—Quail or partridge for export (Wicomico and Worcester Counties considered as one territory).

Worcester—Rabbit, quail, wood cock (except to consumer).

Permitted: Baltimore City—Ruffed grouse may be sold October 1 to December 25.

Massachusetts: All game (except hare and rabbit).

Permitted: Deer, moose, caribou, and elk, lawfully killed and imported into the State, may be sold under license at any time. Dealers may sell under license unplucked entire bodies of pheasants, Scotch grouse, European black game, red-legged partridge, Egyptian or migratory quail, European black plover, and mallard ducks imported from without the United States. The above game must be tagged, fee 5 cents a tag. Dealers or persons in the cold-storage business may sell imported quail lawfully obtained during November and December, and may sell at any time hares or rabbits lawfully secured. Live quail for propagation may be sold under permit.

Michigan: All protected game, except rabbit.

Permitted: Deer skins, and green or mounted buck-deer heads lawfully taken and under permit.

Minnesota: All protected game.

Mississippi: All protected game.

Missouri: All protected game.

Montana: All protected game.

Permitted: Merchant or hotel or restaurant keeper may sell game killed outside the State.

Nebraska: All protected game.

Nevada: All protected game.

New Hampshire: Prohibits the sale for food purposes of the dead bodies of birds belonging to a family any species or subspecies of which is native to and protected by the State.

Permitted: Deer may be sold for food during the open season and for a reasonable time thereafter.

Hares and rabbits may be sold during the open season.

New Jersey: Deer, squirrel, and game birds (except waterfowl, reedbird, and rail), belonging to a family any species of which is native to and protected by the State.

Permitted: Rabbits, rail, reed birds, and waterfowl during open season and 15 days thereafter, certain imported game, and also deer, pheasants, black and mallard ducks coming from another State may be sold at all times of the year if properly tagged.

New Mexico: All protected game taken in the State.

Permitted: Sale of game imported into State by hotel, restaurant, café, or boarding-house keeper, during life of permit.

New York: All game belonging to a family any species or subspecies of which is native to and protected by the State.

Permitted: Varying hares and rabbits legally taken in State during open season (from without State at any time), and unplucked carcasses of pheasants, Scotch grouse, European black game, European black plover, red-legged partridge, and Egyptian quail, and carcasses of European red deer, fallow deer, roebuck, and reindeer imported from without the United States may be sold under license at any time when duly tagged. Tag fee, 5 cents each.

Head, hide, and feet of quadrupeds legally taken and possessed may be sold at any time.

Sale of game prohibited throughout the year—Continued.

North Carolina: Restrictions in a number of counties under local laws.¹

North Dakota: All protected game.

Permitted: Hides, heads, and trophies of big game lawfully taken may be sold at any time.

Ohio: All protected game, except rabbit.

Oklahoma: All protected game.

Permitted: Heads, hides, and horns of big game lawfully killed may be sold.

Oregon: All protected game.

Permitted: Geese killed in Crook, Gilliam, Harney, Morrow, Sherman, Umatilla, and Wasco Counties may be sold during open season when duly tagged. Game birds and animals imported from without the United States, when duly tagged, may be sold September 1 to March 1. Tag fee, 5 cents each.

Pennsylvania: Wild deer, elk, squirrel, rabbit or hare, wild ring-necked pheasant, and Hungarian partridge taken in the State; quail, ruffed grouse (pheasant), wild turkey, and woodcock (wherever taken).

Permitted: Bear, reedbird, black-breasted and golden plover, Wilson or jacksnipe, yellowlegs, coot or mud hen, rail, taken in State, may be sold during open season and 30 days thereafter; waterfowl may be sold September 1 to January 1.

Rhode Island: Quail, ruffed grouse, Hungarian partridge, woodcock, plover, yellowlegs, snipe, curlew, sandpiper, shore, marsh, and beach birds, rail, swan, wood duck.

South Carolina: All game protected by State except wood duck and grackle.

Permitted: Rice birds, ducks, and game not protected by State law may be sold.

South Dakota: All protected game.

Permitted: Hides, heads, or horns of big game lawfully killed may be sold at any time.

Tennessee: All protected game taken in State.

Texas: All game animals, hides and horns, wild birds, and wild fowl found in the State.

Utah: Deer, elk, antelope, sheep, quail, partridge, grouse, prairie chicken, sage hen, pheasants (Mongolian Chinese, and English), dove.

Permitted: Hides and heads of deer legally killed and tagged, and waterfowl may be sold.

Vermont: All protected game birds or species belonging to any family native to the State.

Permitted: Deer may be sold during the open season and for a "reasonable time thereafter," and hares and rabbits during the open season.

Virginia: Quail or partridge, grouse or pheasant, woodcock.

Clarke County.—Rabbit, squirrel, wild turkey (outside of county).

Frederick, Shenandoah Counties—Wild turkey (by nonresidents of the State).

Princess Anne County, Back Bay—Wild fowl (by nonresidents of the State).

Washington: All protected game.

West Virginia: All protected game, except rabbit and rail.

Wisconsin: All protected game, except rabbit and squirrel.

Wyoming: All protected game.

Permitted: Sale of game (except edible portion), on affidavit that it was lawfully captured or was taken from animals lawfully killed, payment of 25-cent fee to the justice of the peace, and attachment of tag issued by him.

Alberta: Grouse, partridge, Hungarian partridge, pheasant, prairie chicken, ptarmigan; other game birds March 1–September 20.

Permitted: The flesh of big game and game birds may be sold under \$10 license. Heads of big game before being sold must be stamped by minister of agriculture at fees of \$5 for elk, caribou, moose, and sheep, and \$2 for deer, antelope, and goat.

¹ *North Carolina:* Sale of game is prohibited by following local laws: *Deer*, Carteret (Newport Township), Craven (to Mar. 5, 1923), Cherokee, Haywood; *squirrel*, Avery (gray or pine squirrel), Craven (to Mar. 5, 1923), Madison, Pender (Rocky Point Township), Transylvania (more than 2 a day), Warren; *quail*, Alamance (to Mar. 8, 1917), Alexander, Anson, Avery, Beaufort, Bladen, Chatham, Cherokee, Clay, Cleveland (to Mar. 7, 1916), Craven (to Mar. 5, 1923), Cumberland, Davidson, Davie, Duplin (outside of county), Guilford, Henderson (for export), Macon, Madison, Montgomery, Moore, Pasquotank, Pender (Rocky Point Township), Pitt, Randolph, Robeson, Rowan, Rutherford, Sampson (for resale or export), Union, Wake, Warren, Wayne, Wilkes, Wilson, Yadkin (outside of county); *duck*, Robeson, Warren; *other game birds*, Avery (lark), Beaufort (pheasant—more than 15 a day), Bladen (wild turkey), Brunswick, New Hanover, and Pender (snipe, woodcock, wood duck), Cherokee (pheasant, dove, robin, woodcock, snipe), Craven (wild turkey, dove, woodcock, snipe), Cumberland (woodcock and snipe), Madison (pheasant), Montgomery (pheasant, turkey), Moore (turkey), Pender (Rocky Point Township—turkey, dove, robin, woodcock), Robeson (dove, robin, woodcock, snipe), Union (dove, lark), Wake (turkey), Warren (turkey, woodcock), Wayne (snipe, woodcock), Wilkes (pheasant). Durham, Orange, and Person prohibit the sale of quail, except by person killing them on his own land; Harnett and Iredell prohibit the sale of quail except during open season by person killing them on his own land; Surry prohibits the sale of quail, except in county by person killing them on his own land or on lands of another under written permission; Vance prohibits the sale of quail, wild turkey, woodcock, and other game birds, except by landowner, tenant, or member of family killing such game on his own land.

Sale of game prohibited throughout the year—Continued.

British Columbia: All game, except under regulations of lieutenant governor in council.

Permitted: Deer may be sold September 1–October 16; moose, caribou in electoral districts of Atlin, Cariboo, and Skeena, October 1–December 16; ducks, geese, and snipe, October 1–November 1. Sale of big game without head attached and birds without plumage prohibited. Heads of big game killed without and imported into the Province may be sold when branded—fees, moose and elk \$5, mountain sheep \$4, and caribou \$3 per head.

Manitoba: Deer, elk, moose, caribou, antelope (except heads and hides), quail, grouse, pheasant, partridge, prairie chicken, woodcock, plover, snipe, sandpiper; ducks by nonresidents.

Permitted: Possession of grouse, prairie chickens, and partridges allowed for forty-five days, and ducks for three months, after close of hunting season. Deer for private use may be possessed at any time on proof of legal killing.

New Brunswick:

Permitted: Gtse and brant during open season and until March 1, and other game during open season and (under license) ten days thereafter. Keepers of hotels, inns, boarding houses, or restaurants may serve game during open season and fifteen days thereafter. Surveyor general may issue \$1 licenses to dealer permitting sale of 3 deer, and heads of same to taxidermists, and licenses to deal in hides or skins of game animals with fees of \$25 to nonresidents or aliens and \$2 to residents.

Newfoundland: Capercailzie, black game.

Permitted: Caribou may be sold from August 1 to January 1; ptarmigan, willow grouse taken in open season may be sold until January 15; other birds may be sold during open season.

Nova Scotia: Deer to 1918, caribou, pheasant, blackcock, capercailzie, Canada grouse (spruce partridge), chukar partridge.

Permitted: Moose (meat only) may be sold from September 17 to November 1 under certificate of lawful killing. Rabbit, December 1 to March 1. Any game bird other than those above mentioned during the open season with the exception of the first three days.

Ontario: Quail, partridge, woodcock, snipe, to September 14, 1917.

Permitted: All other native game may be sold during the open season¹ by the person killing it and by dealers during open season and until the following January 1 under license. Imported game may be sold under special regulations and licenses. Game breeders may sell animals for breeding purposes under permit.

Quebec:² Birch or swamp partridge until October 1, 1917.

Permitted: All game lawfully taken may be sold from the third day of the open season to the fifteenth day of the close season. Hotels, restaurants, and clubs may serve, under license, all game lawfully taken, except birch or swamp partridge. Live animals, and skins and heads of animals lawfully taken may be sold.

Saskatchewan: Sheep, goat; prairie chicken, grouse, pheasant, ptarmigan, or other member of the Gallinae.

Yukon:

Permitted: Deer, elk, moose, caribou, bison, musk oxen, sheep, and goats may be sold during the open season and 60 days thereafter.

DISPOSITION OF GAME RAISED IN CAPTIVITY.

About two-thirds of the States now have some special provision regulating possession, sale, or export of game raised in captivity. About half of these States require a license or a permit either for holding the game or for its export. In Arkansas, Maryland, Missouri, West Virginia, and Wyoming the provisions relate only to big game; in Massachusetts and Ohio only to small game or birds. The tagging system under which game may be sold at certain times has been adopted in at least 10 States—California, Massachusetts, Minnesota, New Hampshire, New Jersey, New York, Oregon, Pennsylvania, Utah, and Vermont. These tags are sold at a nominal rate, varying from 3 cents in California to 5 cents in New York and Oregon.

¹ Ontario.—Seasons depend on regulations of game commission.

² Quebec.—Lieutenant governor in council may prohibit sale of any game for three years or less or prolong any existing period of prohibition for three years or less.

Disposition of game raised in captivity—Continued.

Arkansas: Deer raised in captivity may be exported if shipped open to view. Deer raised in preserves may be possessed, sold, and shipped when accompanied by affidavit from raiser that said deer were raised in captivity.

California: Elk, deer (native or imported), pheasants, partridge, quail, and wild ducks raised in captivity under breeder's license (fee, \$25) may be sold at any time for breeding purposes or may be sold for food when properly tagged (fee, 3 cents a tag) during the following seasons: Deer, Aug. 15–Nov. 2; quail, Aug. 1–Feb. 2; pheasants and partridge, Oct. 1–Jan. 1; ducks, Oct. 15–Mar. 2; licensed breeder may shoot his surplus cock pheasants or cock partridges during February under permit.

Colorado: Game furnished from a private park or lake of class A may be sold by hotels and restaurants at any time. Game taken from licensed private parks may be sold or shipped at any time if accompanied by an invoice.

Connecticut: Deer, pheasants, and wild fowl raised in licensed preserves may be sold or transported at any time.

Illinois: Deer raised in inclosure for market may be killed Oct. 1–Feb. 1; cock pheasants, Nov. 1–Feb. 1, under permit. Game animals and birds raised in captivity under license (fee, \$2) may be sold for propagation or scientific purposes at any time.

Indiana: Game raised in captivity may be killed, sold, or transported at any time.

Iowa: Game raised in captivity under license (fee, \$2) may be sold.

Kansas: Game raised in captivity may be transported under permit of warden for scientific or propagation purposes.

Louisiana: Game raised in captivity may be sold during the open season.

Maryland: Elk, imported and native deer, raised in licensed preserve (fee, \$5) may be sold, dead or alive, at any time (in Allegany and Garrett Counties white-tailed deer native to the State must be branded three months prior to killing). In Washington County game animals and birds reared in licensed preserves (fee, \$10) may be sold for propagation purposes only.

Massachusetts: Pheasants on private preserves may be killed under permit of commissioners. Quail reared in captivity under permit may be exported. Game may be reared in captivity under license (no fee) and sold for propagation under regulations of commissioners; deer, elk, pheasants, quail, European or gray partridge, and wild fowl may be reared in captivity under license (no fee) and sold for food, when properly tagged. Tag fee, 5 cents.

Michigan: Deer raised in captivity may be killed at any time for owner's consumption. Game raised in captivity may be exported under permit, and may be sold alive within the State, and under \$1 permit, alive or dead, without the State.

Minnesota: Game raised in captivity may be sold at any time—game animals under a permit and birds under a tag. Domesticated big game may be exported under permit.

Missouri: Deer and elk raised in captivity under license (fee \$5) may be transported and sold under regulations of the commissioner.

Nevada: Game raised in licensed preserve (fee \$10) may be sold or shipped at any time under invoice.

New Hampshire: Game (except ruffed grouse) raised in private preserve when tagged and marked to show kind and number, names of consignor and consignee, and points of billing and destination, may be exported unaccompanied by the owner. The Blue Mountain Forest Association is permitted to ship deer, elk, and moose killed in its preserve.

New Jersey: Deer raised in licensed preserve may be killed at any time. Deer, introduced pheasants, and mallard and black ducks raised in enclosed licensed preserve, if properly tagged, may be sold for food or exported for sale, if shipped open to view. Live deer may be exported for propagation on payment of \$5 for each animal. Breeder's license fee \$5.

New Mexico: Game raised in licensed preserve may be exported or sold at any time.

New York: Elk, white-tailed deer, European red deer, fallow deer, roebuck, pheasants, mallard, and black ducks raised in captivity under license, may be sold for breeding purposes and may be killed, sold, or exported at any time under license when properly tagged.

North Carolina: Twenty-two counties have laws in regard to certain game raised in captivity.

North Dakota: Domesticated game may be exported and sold under written permission of fish and game board.

Ohio: Game birds and squirrels may be kept in enclosures for domestication.

Oklahoma: Game raised under license (fee \$2) may be transported for propagation at any time, and for food, when properly tagged, during season prescribed by commissioner.

Oregon: Game birds and animals raised in captivity under permit may be exported or sold at any time upon being properly tagged by commissioner or deputy. Tag fee, 5 cents each.

Pennsylvania: Deer, elk, Belgian or German hares, and ring-necked pheasants, raised and killed in captivity, may be sold when properly marked and tagged. Elk raised in captivity may be exported under regulations of the commission. Introduced pheasants and Belgian hares raised in captivity may be exported alive.

South Dakota: Game raised in captivity may be exported or sold under written permission of State game warden.

Utah: Game raised in licensed preserve (fee \$25) may be sold when properly tagged (one pair in four of game reared in private preserves must be released in State under direction of commissioner or deputy).

Disposition of game raised in captivity—Continued.

Vermont: Game raised in private preserves may be exported at any time when duly marked and tagged, and may be sold for propagation at any time, or for food, under tag in accordance with regulations of commissioner.

Washington: Game raised in captivity may be exported under permit from State warden or county game commission, and may be killed and sold at any time.

West Virginia: The owner of elk kept in inclosure may kill them at any time, and may pursue and recapture, by killing or otherwise, elk which have escaped from his inclosure. Tame deer may be killed by the owner.

Wisconsin: Domesticated deer, moose, elk, caribou, and game birds may be shipped or sold under permit of the conservation commission.

Wyoming: Natural increase of big game (except moose) captured and held for propagation may be exported or sold.

LIMITS.

Laws limiting the amount of game which may be killed in a day or a season are now in force throughout the United States, except in Kentucky, Rhode Island, Virginia (except Back Bay), and the District of Columbia, and in all the Canadian Provinces except Prince Edward Island. These measures are of comparatively recent origin.

One of the first bag-limit statutes on birds, passed in Iowa in 1878,¹ restricted the number of prairie chickens, woodcock, quail, and ruffed grouse to 25 a day. These limits remained unchanged for 35 years until the legislature of 1915 reduced the number of prairie chickens to 8 a day and quail to 15 a day. The first limit law on big game, passed in Maine in 1883, restricted the number killed by one individual in a season to 1 moose, 2 caribou, and 3 deer. In recent years the limits have been materially reduced and only a few States now allow more than 1 deer in a season or more than 20 quail or 25 waterfowl in a day.

Limits fixed by law for the capture of game.

Alabama: One deer, 2 turkey gobblers, 25 of each other kind of birds a day.

Alaska: Three deer, 2 moose, 3 caribou, 3 sheep, and 3 brown bears a season; 25 grouse, ptarmigan, shore birds, or waterfowl a day.

Arizona: Two deer, 3 turkeys a season, 25 each of quail or ducks, 35 doves or white wings a day.

Arkansas: Two deer, 1 bear, 4 turkeys a season; hunting parties may average season's limit for each member; 15 quail, 25 ducks a day.

California: Two deer, 12 tree squirrels a season; 15 cotton-tail or bush rabbits a day or 30 a week; 4 grouse a day or 8 a week; 4 sage hen a day or 8 a week; 10 mountain quail a day or 20 a week; 15 valley or desert quail a day or 30 a week; 15 Wilson or jack snipe, black-breasted or golden plover, or yellowlegs a day or 30 a week; 15 mourning doves a day; 25 ducks or geese a day or 50 a week; 12 honkers or black sea brant a day or 24 a week.

Colorado: Twenty game birds a day, 30 in possession. Persons under 12 years of age limited to half this number of birds.

Connecticut: Six gray squirrels a day, 30 a season; 5 rabbits a day, 35 a season; 5 each of quail, ruffed grouse, pheasant, Hungarian partridge, woodcock a day, 36 a year; 35 rail, 50 each of plover, snipe, shore birds, and 25 waterfowl a day.

Delaware: Six animals, 50 rail, 20 ducks, 12 other birds or fowl, except plover, snipe, and reedbirds, a day.

District of Columbia: No limits.

Florida: Three deer, 10 turkeys, and 300 other game birds a year; 1 deer, 2 turkeys, 20 quail, and 25 each of other species a day.

Georgia: Three deer, 3 turkey gobblers a season; 40 doves or snipe, 50 ducks, and 25 each of any other species of game birds a day.

Idaho: Two deer, 1 elk, 1 ibex, 1 goat, 1 sheep a season; 18 quail, 12 each of partridges, sage hens, grouse, pheasants, 24 doves, plover, snipe, ducks, 4 geese a day; but not more than 24 of all kinds in possession.

¹ This statute was, however, preceded by one enacted in 1874 permitting the shipment of a dozen game birds a day, provided the birds were not shipped for sale (ch. 69, sec. 1).

Limits fixed by law for the capture of game—Continued.

- Illinois:** Fifteen squirrels, 12 quail, 3 prairie chickens, 2 cock pheasants, 10 doves, 15 black-breasted and golden plover, 15 snipe, 15 yellowlegs, 15 coots, rail, and gallinule, 15 ducks, 10 geese, 10 brant, 15 other waterfowl a day. Limit in possession, 30 squirrels, 36 quail, 12 prairie chickens, 40 doves, 50 black-breasted and golden plover, jacksnipe, and yellowlegs, 60 coots, rails, and gallinules, 60 ducks, 20 geese, or brant.
- Indiana:** Fifteen quail, 5 prairie chickens, 15 ducks or other waterfowl a day; 45 birds in possession as result of 3 or more days' consecutive hunting.
- Iowa:** Fifteen quail a day, 25 in possession; 8 prairie chickens a day, 16 in possession; 25 each of all animals, birds, and game a day or in possession; 50 ducks in possession.
- Kansas:** Twenty each of doves, plover, ducks, 12 snipe and 6 each of geese and brant a day.
- Kentucky:** No limits.
- Louisiana:** Two deer a day or in possession, 5 a season; 15 squirrels, 1 turkey gobbler, 25 doves, ducks, poule d'eau, or chorooks, 50 snipe, 15 of any other game birds a day. Market hunters, 50 ducks or poule d'eau a day.
- Maine:** Two deer a season (except in Androscoggin, Cumberland, Knox, Kennebec, Lincoln, Sagadahoc, Waldo, and York Counties, limit 1, and in lumber camps, limit 6); 5 each of ruffed grouse and plover, and 10 each of woodcock, snipe, and ducks a day.
- Maryland:** One deer a season; 12 rabbits, 12 squirrels, 15 quail (partridges), 6 ruffed grouse (pheasants), 3 English pheasants, 2 wild turkeys, 25 doves, 12 woodcock, 12 jacksnipe a day; 50 rail (ortolan) per tide.
Exceptions.—Baltimore, per day: 6 rabbits, 1 jack rabbit, 8 squirrels, 10 quail (partridges), 2 ruffed grouse (pheasants), 1 English pheasant, 1 ring-necked pheasant, 1 wild turkey, 10 doves, 8 woodcock, 12 jacksnipe; per tide, 50 rail. Calvert, per day: 6 rabbits, 12 partridges. Cecil, per day: 5 rabbits, 6 squirrels, 12 quail (partridges), 4 ruffed grouse (pheasants), 12 woodcock, 15 snipe, 50 rail, 50 blackbirds, 20 Bartramian sandpipers (grass plover), 20 marsh plover, and 25 each of teal, wood, mallard, black, sprigtail, and crow-bill ducks. Garrett, 6 birds a day. Patuxent River, per day: 75 rail (ortolan), 175 reedbirds.
- Massachusetts:** One deer; 15 gray squirrels, 15 ruffed grouse, 20 woodcock, 20 quail a season; 5 gray squirrels, 3 ruffed grouse, 4 woodcock, 4 quail, 15 black ducks a day; pheasants, in counties having open season, 2 a day, 6 a season.
- Michigan:** One deer a season; partridge, 6 a day, 15 in possession, 25 a season; woodcock, 6 a day, 20 in possession, 25 a season; plover, snipe, yellowlegs, 10 a day, 20 in possession, 25 a season; ducks, geese, brant, 25 a day, 50 a week (calendar week).
- Minnesota:** Licensed resident, 1 deer or 1 moose a season (nonresident, 1 of each); 15 ducks, 10 other birds combined a day; 45 ducks, 30 other birds combined in possession.
- Mississippi:** One deer a day, 5 a season; 20 each of quail, wild turkeys, robins, cedarbirds, plover, tatlers, chorooks, grosbeaks, coots, poule d'eau, rails, ducks, geese, brant, swans a day.
- Missouri:** One deer, 2 turkeys, 10 quail, 15 of any other species of birds a day; or 2 deer, 4 turkeys, 15 quail, 25 of any other species of birds in possession.
- Montana:** Two deer, 1 elk a season; 5 each of grouse, partridges, prairie chickens, fool hens, pheasants, sage hens, and 20 ducks a day.
- Nebraska:** Ten each squirrels, quail, prairie chickens or grouse, wild geese or brant, and 25 game birds of any other variety a day; 20 squirrels, 10 prairie chickens or grouse, 10 wild geese or brant, or 50 other game birds in possession.
- Nevada:** One deer, 1 antelope a season; 20 mountain quail, 20 valley quail, 10 sage hens, 6 grouse, 5 plover, and 15 snipe, 20 ducks a day or in possession.
- New Hampshire:** Two deer a season in Coos, Carroll, and Grafton Counties, 1 in rest of State; 5 hares or rabbits a day; 5 squirrels a day or in possession; 5 quail a day; 10 ruffed grouse a day, 50 a season; 10 woodcock a day, 50 a season; 20 ducks a day.
- New Jersey:** One deer a season; 10 rabbits, 10 quail, 3 ruffed grouse, 3 English or ringneck pheasants, 3 Hungarian partridges, 10 woodcock, 30 marsh hens, 20 ducks, 10 each of geese and brant a day or in possession. (Not applicable to dealer in game, hotel keeper, etc., during open season at place of business.)
- New Mexico:** One deer a season; 3 wild turkeys, 5 grouse, 20 quail, 20 doves, 20 ducks a day or in possession.
- New York:** Two deer, 20 woodcock, 20 grouse, 3 male imported pheasants a season; 6 varying hares or rabbits, 5 squirrels, 4 woodcock, 4 grouse, 25 waterfowl (limit for one boat or battery, 40), 15 rails, coots, mudhens or gallinules (limit for one boat, 20), 15 shore birds (limit for one boat, 25) a day.
- Long Island:** Fifty quail, 20 ruffed grouse, 36 male pheasants a season; 10 quail, 4 ruffed grouse, 6 male pheasants, and 6 cottontails or varying hares a day.
- North Carolina:** Beaufort, quail, ruffed grouse, 15 a day combined; Brunswick, New Hanover, [Pender, 15 marsh hens a day; Buncombe, 2 deer a season, 25 partridges, pheasants, wild turkeys, or doves a day; Cabarrus, Mecklenburg, 15 quail (partridges) a day; Clay, 20 quail a day; Cleveland, 10 quail (partridges) a day; Craven, 10 squirrels a day; Dare, 5 deer a season; Haywood, 1 buck a day, 2 a season; 1 pheasant, 1 wild turkey, 15 other birds a day; Henderson, Jackson, 2 bucks a season; Lenoir, 25 quail a day for individual or party; Lincoln, 10 quail a day; Madison, 25 birds a day; Robeson, 12 quail, doves, snipe, ducks a day; Transylvania, 3 deer a season, 5 squirrels, 20 quail (partridges) a day; Vance, 15 game birds a day.

Limits fixed by law for the capture of game—Continued.

- North Dakota:** Ten prairie chickens, grouse, plover, combined a day, 20 in possession at one time; 15 snipe, woodcock, rail, ducks, geese, combined, 30 in possession.
- Ohio:** Five squirrels, 12 each of plover, snipe, woodcock, shore birds, rail, geese, 25 ducks a day.
- Oklahoma:** One deer a season; 1 turkey (male) March 15–April 15, 1 turkey, November 15–January 1; 10 quail, plover, snipe, or ducks a day, 100 a season, 10 geese or brant a day, 1 swan a season.
- Oregon:** Three deer a season; 5 silver gray squirrels and 10 quail in 7 consecutive days; 5 sage hens a day, 10 in 7 consecutive days in district 2; 5 ruffed grouse, pheasants, sooty or blue grouse, sage hens, prairie chickens, and Chinese pheasants (only 2 of which may be females) a day, 10 in 7 consecutive days; 10 doves (State) a day, 20 in 7 consecutive days; 30 shore birds, rail, coot, ducks, and geese in 7 consecutive days.
- Pennsylvania:** One deer, 1 bear a season; 6 squirrels a day, 20 a week, 40 a season; 10 rabbits a day, 30 a week, 60 a season; 3 hares a day, 15 a week, 30 a season; 8 quail a day, 25 a week, 40 a season; 5 ruffed grouse a day, 20 a week, 30 a season; 4 ring-necked pheasants a day, 10 a week, 20 a season; 4 Hungarian partridges a day, 10 a week, 20 a season; 10 woodcock a day, 20 a week, 30 a season; 1 wild turkey a week, 2 a season. (Week begins Monday morning and ends Saturday night.)
- Rhode Island:** No limits.
- South Carolina:** Five deer a season; 25 quail (partridges), 2 wild turkeys, 25 doves, 12 woodcock a day.
- South Dakota:** One deer a year; 20 waterfowl, 10 other birds a day; 25 partridges, ruffed grouse, prairie chickens, sharp-tailed (white-breasted) grouse, pheasants, woodcock, golden plover and upland plover in aggregate in possession at one time; 50 snipe and waterfowl in all in possession.
- Tennessee:** Unlawful to kill more than 20 game birds or animals a day.
- Texas:** Three deer a season; 15 birds a day (3 wild turkeys December 1 to March 1).
- Utah:** One deer (residents only) a season; 15 quail or doves, 8 other upland birds combined a day or in possession; 12 geese a day, and 25 in all of snipe, ducks, geese a day.
- Vermont:** One deer and 25 ruffed grouse or woodcock a season; 5 each of rabbits or gray squirrels a day or in possession; 4 each of quail, ruffed grouse, partridges, or woodcock a day; 10 in all of plover, English snipe, and other shore birds a day; 20 ducks a day.
- Virginia:** Back Bay, Princess Anne County, 35 ducks, geese, and brant a day.
- Washington:** Two deer, 1 goat, 1 caribou a season; 5 in all of partridges, grouse, prairie chicken, Hungarian partridges, and imported pheasants, 10 quail a day; 25 upland game birds a week; in Kittitas County, 3 in all of sharp-tailed grouse, sage grouse, Chinese or English pheasants, Hungarian partridges a day; 20 ducks, geese, brant, golden plover, jack or Wilson snipe, greater and lesser yellowlegs a week (week ends midnight Saturday night). Limit in possession, 30 ducks, geese, or brant. If the bag of upland game birds includes quail, the limit is 10 a day.
- West Virginia:** Two deer a season; 12 squirrels a day, 100 a season; 12 quail a day, 96 a season; 6 ruffed grouse a day, 25 a season; 2 wild turkeys a day, 6 a season.
- Wisconsin:** One deer a year; 5 grouse, prairie chickens, woodcock, 10 partridges (2 in Ozaukee and Washington Counties), 15 plover, snipe, coots, rail, rice hens, ducks (except wood duck), 10 geese or brant a day; 20 of all kinds of birds in possession by resident in one day. Local limits: Rabbit in Ozaukee, Washington, and Waushara Counties, 10 a day; in Dodge, Jefferson, Manitowoc, and Waushara Counties, 15 a day; squirrel in Dodge and Jefferson Counties, 15 a day; in Waushara, 10 a day.
- Wyoming:** One deer, 2 elk (resident, 1 elk, and 1 additional elk under special license), 1 male sheep a season; 18 birds (of which not more than 6 may be grouse) a day or in possession.
- Alberta:** One deer, 1 moose, 1 caribou, 2 sheep, 2 goats a season; 10 grouse, partridges, pheasants prairie chickens, ptarmigan a day, or 100 a season; 5 Hungarian partridges a day, 25 a season.
- British Columbia:** Three deer of any one species, 4 in all; 1 elk, 2 moose (1 in county of Kootenay), 3 caribou, 3 goats, 2 sheep (1 in county of Kootenay), 250 ducks and snipe a season; 12 grouse, 12 prairie chickens, and 6 pheasants a day or in possession.
- Manitoba:** One in all of deer, elk, moose, caribou, and antelope a season; 20 in all of grouse, partridges, ptarmigan, prairie chickens a day, 100 a season; 20 ducks a day in September, 50 ducks a day in October and November; 10 geese a day.
- New Brunswick:** Two deer, 1 moose, 1 caribou a season (lumber camp limited to 2 moose, 2 caribou a season); 10 partridges, 10 woodcock, 20 ducks a day.
- Newfoundland:** Three caribou (stags) a season.
- Nova Scotia:** One moose a season; 5 ruffed grouse, 10 woodcock a day.
- Ontario:** One deer, 1 moose, 1 caribou a season; 10 partridges a day, 200 ducks a season. Two or more persons hunting together under license may kill an average of 1 deer each.
- Prince Edward Island:** No limits.
- Quebec:** Zone 1: Two deer, 1 moose, 2 caribou a season. Zone 2: Two deer, 1 moose, 4 caribou a season; 3 deer and 3 caribou additional may be taken by persons domiciled in Province under \$5 permit.
- Saskatchewan:** Two in all of deer, elk, moose, caribou a season; 10 in all of grouse, partridges, pheasants prairie chickens, ptarmigan a day, or 100 a season; 50 waterfowl a day, 250 a season.
- Yukon:** Six caribou or deer, 2 moose, 2 elk, 2 sheep, 2 goats, 2 musk oxen a season.

MINIMUM AGE LIMITS FOR HUNTING.

With the general adoption of the license system has come the necessity of fixing a minimum age at which licenses may be issued. The practice is by no means uniform, but about half of the States have restrictions of some sort. These restrictions are of three general kinds:

- (1) Exemption from the hunting license requirement for children;
- (2) Refusal to issue licenses to children; and
- (3) Requirement that children must have the written consent of the parent or guardian to obtain a license.

Children under 12 are not required to have a license in Idaho or Utah; under 14 in Montana, Nevada, Oklahoma, or Oregon; under 17 (hunting small game) in Michigan; under 21 (hunting small game) in Minnesota. Children under 13 in New Hampshire and Nebraska and under 17 in Arizona do not require a license when hunting with a licensed adult. New Jersey prohibits children under 10 from hunting with firearms, but upon application of parent or guardian issues a \$1 license to citizens of the United States between the ages of 10 and 14, provided they hunt in company with a licensed adult. Pennsylvania also prohibits children under 14 from hunting, but issues licenses to minors between the ages of 14 and 16 upon application of parent or guardian.

Licenses are not issued to children under certain ages, or only upon written consent of the parent or guardian, in the following States:

Not issued under certain age:	Age.	Written consent required:	Age.
New Jersey.....	10	Indiana.....	14
Pennsylvania.....	14	West Virginia.....	15
Wyoming (for birds).....	14	Pennsylvania.....	14 to 16
Wyoming (big game).....	15	Ohio.....	16
Rhode Island.....	15	Vermont.....	16
Wisconsin.....	15	British Columbia.....	16
Connecticut.....	16	Saskatchewan.....	18
New Brunswick (big game).....	16	Iowa.....	18
		New Hampshire.....	18

LICENSES FOR HUNTING AND SHIPPING GAME.

In Arkansas nonresidents are not permitted to hunt, except on their own premises. In all the States and throughout Canada licenses must be secured before nonresidents can hunt any or certain kinds of game (see fig. 3, p. 56). In 42 States and 7 Canadian Provinces a like restriction is imposed on residents, but the fees are usually much smaller, and often are merely nominal (see fig. 4, p. 56).

A special kind of hunting license, often known as the "alien" license, is being generally adopted to restrict hunting by persons who are not citizens of the country, and is now in force in about half of the States. Following the example of Pennsylvania, the States of Massachusetts, New Jersey, North Dakota, and West Virginia now prohibit aliens from hunting or owning or possessing guns.

In Maine,¹ Wyoming, New Brunswick (on wild lands), and Nova Scotia nonresidents are not permitted to hunt big game unless accompanied by qualified guides.

Landowners or taxpayers are not required to pay the usual fee in a number of States, and no license is required in Texas or Nova Scotia of those hunting in their own county. Special exemptions are made in favor of nonresident members of fish and game clubs by Massachusetts, Rhode Island, and Quebec. In Virginia no license is required of bona fide guests of residents, and in Ontario no fee is charged for a guest license.

In Alberta the resident big-game license is not required in the northern part of the Province. In Newfoundland free hunting licenses are granted to officers of British warships stationed on the coast for the protection of fisheries. Manitoba provides that the Governor General of Canada, the premier and lieutenant governor, or the premier of any Province may be granted complimentary licenses. Officers of the army or navy stationed in Nova Scotia, nonresident landowners paying taxes to the amount of \$30 or more annually in Nova Scotia, and nonresidents owning real estate in Prince Edward Island to the value of \$325 and paying taxes thereon, are required to pay fees of \$5 only. The son or brother of a bona fide resident returning to Prince Edward Island may obtain a license on payment of \$2.50 and a resident may obtain a nonresident guest license for \$2.25 per week, provided he receives no compensation from such guest. In Ontario the lieutenant governor in council is authorized to reduce nonresident license fees to the amount charged residents of Ontario by the Province of which applicant is a resident; and any farmer living on his own land in the districts of Haliburton, Muskoka, Parry Sound, Nipissing, Algoma, Thunder Bay, Rainy River, Sudbury, Manitoulin, or Kenora may take one deer a season for his own use without securing the prescribed license. In Quebec, in the discretion of the minister of colonization, mines, and fisheries, poor Indians or settlers may not be compelled to take out the \$5 resident license required for an additional number of deer and caribou.

Details in regard to hunting licenses² are given in the table on pages 57-63. In every case the fee includes the amount charged for issuing the license. The term "commissioner" unless otherwise qualified means the game or fish commissioner.

¹ *Maine*: On wild lands of the State, except from Dec. 1 to 15.

² Licenses for fishing with hook and line are now issued in 22 States as follows:

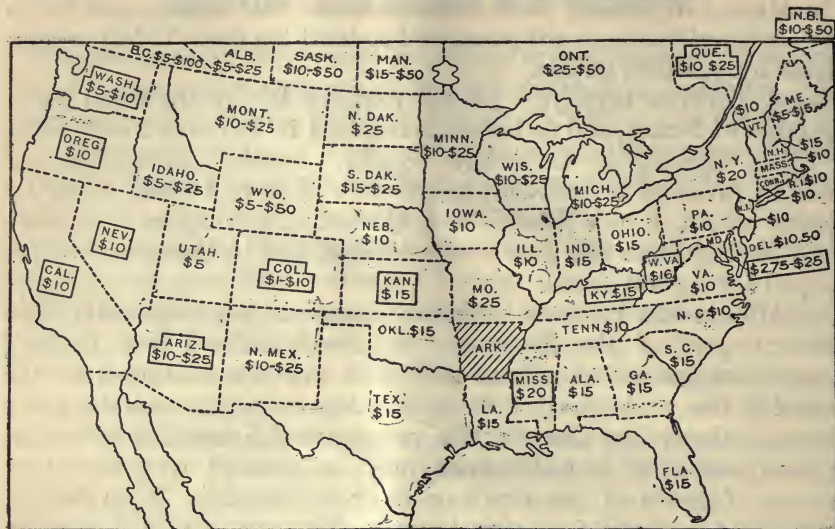
Combination hunting and fishing licenses are issued in 14 States: Arizona, Colorado, Idaho, Indiana, Montana, Nebraska, Nevada, New Jersey, New Mexico, Oregon, Utah, Vermont, Washington, and Wyoming. For fees, see pp. 57-61.

General fishing licenses, issued to either residents or nonresidents, are required in Nevada (30-day license), \$2; Oregon, \$1; and Vermont, \$0.60.

Special resident fishing licenses are required in California, \$1; and New Mexico, \$1.

Nonresident fishing licenses are required in California, \$3; Colorado, \$2; Delaware, \$3.50; Idaho, \$2; Indiana, \$1; Michigan, \$1 (special), \$3 (general); Minnesota, \$1; Montana, \$2 (alien, \$5); Nebraska, \$2; New Mexico, \$5; South Carolina, \$5; South Dakota, \$2; Washington, \$2 (county); West Virginia, \$5; and Wisconsin, \$1.

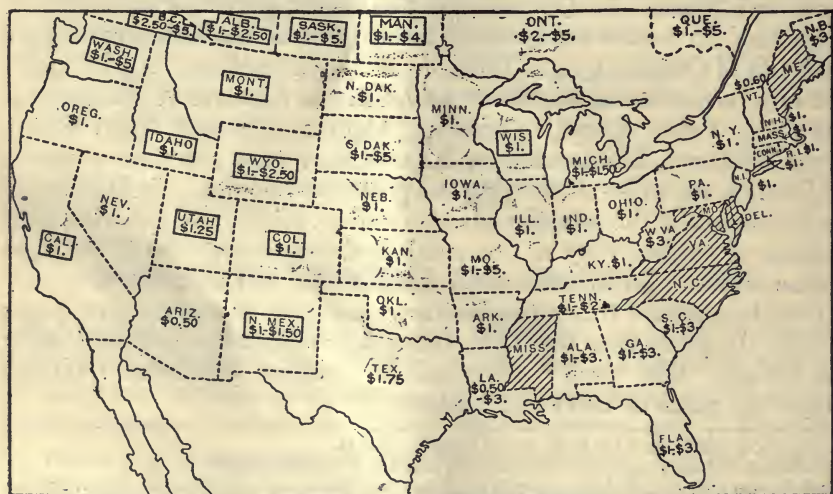
Fishing licenses are not required in Idaho of women who are residents; in Indiana of residents fishing in their own county or an adjoining county, nor of the wife of a nonresident licensee; in Michigan and Vermont of women who are nonresidents; and in Nebraska and Wisconsin of any women.



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FIG. 3.—States and Provinces which require nonresidents to obtain hunting licenses.

[In Connecticut, Delaware, Illinois, Indiana, Iowa, New Jersey, New York, North Carolina, Ohio, Rhode Island, South Carolina, and Vermont an additional fee of 15 to 50 cents is charged for issuing the license. Inclosed names indicate the States which do not permit licensees to take a limited amount of game out of the State. Alaska and Newfoundland have \$50, Nova Scotia \$30 and \$15, and Prince Edward Island \$15 nonresident licenses, with export privileges. Arkansas does not permit hunting by nonresidents, except on their own land.]



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FIG. 4.—States and Provinces which require residents to obtain hunting licenses.

[In Connecticut, New Jersey, New York, Ohio, Oklahoma, Pennsylvania, Rhode Island, and South Carolina an additional fee of 10 to 25 cents is charged for issuing the license. West Virginia requires a county license for which no fee is charged. Nova Scotia and Newfoundland have \$5 resident licenses for hunting caribou. Note that many of the States adopt the French method of exempting landowners, while a few in the West (indicated by lines inclosing name of State), follow the English method of requiring everyone who hunts to obtain a license.]

Details of hunting and shipping licenses.

UNITED STATES.

State and kind of license.	Fee.	By whom issued.	Details of license.
Alabama:			
Nonresident.....	\$15.00	Probate judge.....	
Alien.....	15.00	do.....	
Resident.....	3.00	do.....	State license.
Do.....	1.00	do.....	County license.
Alaska:			
Nonresident.....	50.00	Governor.....	
Alien (nonresident).....	100.00	do.....	
Guide.....		do.....	American citizen or native of Alaska. Fee fixed by governor.
Shipping (resident) ¹	40.00	do.....	Export of heads or trophies by resident.
Do.....	10.00	do.....	Do.
Do.....	5.00	do.....	Do.
Shipping (special) ¹	150.00	do.....	Export of moose from southern Alaska.
Arizona:			
Nonresident.....	25.00	Warden or license collector	Deer and wild turkey.
Do.....	10.00	do.....	Birds and fish.
Alien.....	100.00	do.....	Deer.
Do.....	25.00	do.....	Birds and fish.
Resident.....	.50	do.....	General. Duplicate license, 10 cents.
Arkansas:			
Resident.....	1.00	Commission.....	Deer. Nonresidents not permitted to hunt. ²
California:			
Nonresident.....	10.00	Fish commissioner or county clerk.	Expires June 30.
Alien.....	25.00	do.....	Do.
Resident.....	1.00	do.....	Do.
Colorado:			
Nonresident or alien.....	10.00	Commissioner or county recorder.	
Do.....	2.00	do.....	County license—birds, good for 1 week.
Do.....	1.00	do.....	County license—birds, good for 1 day.
Do.....	12.00	do.....	Hunting and fishing license.
Resident.....	1.00	do.....	Do.
Guide.....	5.00	Commissioner.....	Must also have State hunting license.
Connecticut:			
Nonresident.....	10.25	City or borough clerk.....	Hunting and trapping.
Alien.....	15.25	do.....	
Resident citizen.....	1.25	do.....	
Delaware:			
Nonresident.....	10.50	Commission.....	
Florida:			
Nonresident or alien.....	15.00	County judge.....	County license.
Resident.....	3.00	do.....	Required of resident of State, non-resident of county.
Do.....	1.00	do.....	County license; not required of resident Confederate veteran entitled to a State pension.
Georgia:			
Nonresident.....	15.00	Commissioner or county warden.	State license.
Resident.....	3.00	do.....	Do.
Do.....	1.00	do.....	County license good only in county of residence; not required in militia district. Expires Feb. 1.
Idaho: ³			
Nonresident or alien.....	25.00	Warden and deputies.....	Big game. Expires Mar. 31.
Do.....	5.00	do.....	Birds only.
Resident citizen.....	1.00	do.....	Hunting and fishing. Not required of women.
Illinois:			
Nonresident or alien.....	10.50	County clerk.....	Expires June 1.
Resident.....	1.00	City or county clerk.....	

¹ *Alaska*: Not more than one general (\$40) license and two special (\$150) moose licenses issued to one person in one year. Each shipper must file with the customs office at port of shipment an affidavit that he has not violated the game law; that the trophy to be shipped has not been bought or purchased, has not been sold, and is not shipped for purpose of sale; that he is the owner of the trophy, and, in case of moose, whether the animal from which it was taken was killed north or south of latitude 62°.

² *Arkansas*: But see *State v. Mallory*, 83 S. W., 955, deciding that nonresidents may hunt on their own land. A resident is required to obtain written permission for hunting on inclosed land of another.

³ *Idaho*: Not required of veterans of the Civil War.

Details of hunting and shipping licenses—Continued.

UNITED STATES—Continued.

State and kind of license.	Fee.	By whom issued.	Details of license.
Indiana: ¹			
Nonresident.....	\$15.50	Clerk of circuit court.....	Hunting and fishing. Good for 1 year. Civil War veterans excepted. Do.
Resident.....	1.00	Commissioner or clerk of circuit court.	Do.
Iowa:			Expires July 1.
Nonresident.....	10.50	County auditor.....	
Resident.....	1.00	do.....	
Kansas:			
Nonresident.....	15.00	Secretary of state.....	
Resident.....	1.00	County clerk.....	
Kentucky:			
Nonresident or alien.....	15.00	County clerk.....	
Resident.....	1.00	do.....	
Louisiana:			
Nonresident or alien.....	15.00	Tax collector.....	Issued to residents only.
Market hunting.....	10.00	do.....	State license.
Resident.....	3.00	do.....	County license not required in ward of residence.
Do.....	.50	do.....	
Trapper.....	2.00	do.....	
Maine:			
Nonresident.....	15.00	Commissioners.....	All game, Oct. 1-Jan. 1.
Do.....	5.00	do.....	Game that may be shot before deer season in certain counties. Holder may obtain big-game license by paying \$10 additional.
Resident alien.....	15.00	do.....	Not required of aliens who pay taxes or who have resided in State 2 years continuously prior to application.
Camp keeper.....	5.00	do.....	
Guide (nonresident).....	20.00	do.....	Guide to be registered, and to guide not more than 5 persons at a time.
Guide (resident).....	1.00	do.....	Guide to be registered, and to guide not more than 5 persons at a time.
Shipping (resident).....		do.....	Moose, \$5; deer, \$2; one pair of game birds in 7 days, 50 cents.
Trapper.....	5.00	do.....	
Maryland:			
Nonresident ¹	{ 5.00 25.50 }	Clerk of circuit court ²	Separate county laws.

¹ Maryland: County and local licenses are issued at the following rates, including clerk fees:

Allegany.....	\$10.50	Kent.....	^b 15.00
Baltimore.....	^a 10.00	Montgomery.....	15.50
Calvert.....	10.50	Patuxent River.....	^c 11.00
Caroline.....	5.00	Prince George.....	20.50
Carroll.....	10.50	Queen Anne.....	4.50
Cecil.....	10.00	St. Mary.....	20.50
Charles.....	5.50	Somerset.....	^a 10.50
Dorchester.....	^a 10.00	Talbot.....	10.00
Frederick.....	15.50	Washington.....	^d 10.50
Garrett.....	10.00	Wicomico.....	10.50
Harford.....	5.15	Worcester.....	10.00
Howard.....	8.00		

^a Residents of State, Baltimore and Dorchester (fee, \$5); Somerset (\$2.75).

^b Fee only \$5.50 if invited by resident landowner.

^c Club license, \$25.

^d Not required if written permission be secured from landowner or lessee.

Guests: Guests of landowners are required to obtain licenses, only in Allegany, Baltimore, Caroline, Cecil, Dorchester (except relatives of host), Garrett, Kent, Somerset, Talbot, and Worcester Counties.

Resident licenses: Required in Baltimore and Dorchester (fee \$1), Harford (\$1.15).

Sinkbox, sneakboat, blind, pusher—Cecil: Sneakboat (Bohemia and Elk Rivers), \$5.50; sinkbox (Bohemia, Elk, and Sassafras Rivers), \$10.50. Anne Arundel: Pusher, \$2; booby and brush blinds (west side Chesapeake Bay), \$5; (South River), \$2.50; Harford: Sinkbox, \$20.75; sneakboat, \$5.75. Kent: Sinkbox, \$20; blind, \$5. Queen Anne: Sinkbox, \$10.50; sneakboat, \$5.75; booby, blind, \$2.50; Susquehanna Flats: Sinkbox, \$20.75; sneakboat, \$5.75. Talbot: Sinkbox, \$5; blind or sinkbox (Dickson Bay), \$5. Patuxent River: Pusher, \$2.50 (required of residents to push or paddle nonresidents).

Anne Arundel prohibits hunting by nonresidents of the county except by permission of landowners, and Charles prohibits hunting of waterfowl by nonresidents.

² In Cecil County by the Cecil County Game Protective Association; in Harford County by justice of the peace.

*Details of hunting and shipping licenses—Continued.***UNITED STATES—Continued.**

State and kind of license.	Fee.	By whom issued.	Details of license.
Massachusetts:			
Nonresident.....	\$10.00	Commissioners.....	
Resident.....	1.00	City or town clerk.....	
Michigan:			
Nonresident or alien.....	25.00	County clerk.....	Deer.
Do.....	10.00	do.....	Small game only.
Resident.....	1.50	do.....	Deer.
Do.....	1.00	do.....	Small game.
Export.....	10.00	State warden.....	
Minnesota:			
Nonresident.....	25.00	Commissioner.....	Game animals.
Do.....	10.00	do.....	Game birds.
Resident.....	1.00	County auditor.....	Deer and moose.
Do.....	1.00	do.....	Game birds.
Nonresident (trapper).....	10.00	do.....	
Mississippi:			
Nonresident.....	20.00	Sheriff.....	County license.
Missouri:			
Nonresident.....	25.00	Commissioner.....	
Resident.....	5.00	County clerk or license collector.	State license.
Do.....	1.00	do.....	County license. Required in county of residence or adjoining counties.
Montana:			
Nonresident.....	25.00	Warden.....	Hunting and fishing.
Do.....	10.00	do.....	Birds and fish.
Alien.....	30.00	do.....	Birds and fish (gun license required, fee \$25).
Resident ²	1.00	Warden or justice of peace.	Birds and fish.
Guide.....	10.00	Warden.....	Issued to residents only.
Shipping (resident).....	.50	do.....	Permits limited exports in open season.
Nebraska:			
Nonresident.....	10.00	Commissioner or county clerk.	Hunting and fishing.
Resident.....	1.00	do.....	Hunting and fishing. Not required of women.
Nevada:			
Nonresident.....	10.00	County clerk or warden.....	Not required of women.
Alien.....	25.00	do.....	Do.
Resident.....	1.00	do.....	Do.
New Hampshire:			
Nonresident or alien.....	15.00	Commissioner or town clerk.	
Resident.....	1.00	do.....	
Guide.....	1.00	Commissioner.....	Resident.
Do.....	20.00	do.....	Nonresident.
New Jersey:³			
Nonresident.....	10.15	County, city, or town clerk and salaried wardens.	
Resident citizen.....	1.15	do.....	Hunting and fishing.
New Mexico:			
Nonresident or resident alien.....	30.00	County clerk or deputy.....	All game and fish.
Do.....	25.00	do.....	Game.
Nonresident.....	10.00	do.....	Birds.
Nonresident alien.....	55.00	do.....	All game and fish.
Do.....	50.00	do.....	Game.
Resident.....	2.00	do.....	All game and fish.
Do.....	1.50	do.....	Game.
Do.....	1.00	do.....	Big game, including turkeys.
Do.....	1.00	do.....	Game birds except turkeys.
Guide.....	5.00	do.....	Issued to residents only.
New York:			
Nonresident or alien.....	20.50	County, city, or town clerk	Fee for nonresident taxpayer \$10.50. Alteration, etc., forgery, second degree.
Resident.....	1.10	do.....	Alteration of license forgery.

¹ *Massachusetts:* Members of incorporated game clubs owning real estate assessed at not less than \$1,000 and organized prior to 1907, owners, or their minor children over 18 years old, of real estate assessed at not less than \$500, or nonresidents invited (for not more than 4 days) by members of incorporated club for hunting foxes, pay a fee of \$1.

² *Montana:* United States officers and soldiers stationed in the State, students of any institution of learning, and officers of the United States Forest Service classed as residents.

³ *New Jersey:* Unnaturalized, foreign-born person prohibited from hunting or owning shotgun or rifle unless he is the owner of real property to the value of \$2,000 above all encumbrances.

Details of hunting and shipping licenses—Continued.

UNITED STATES—Continued.

State and kind of license.	Fee.	By whom issued.	Details of license.
North Carolina:			
Nonresident (Audubon).....	\$10.25	Clerk of superior court....	Good only in 32 counties not covered by the following or by local licenses.
Nonresident (special) ¹	10.50	do.....	Good only in county of issue.
North Dakota:			
Nonresident.....	25.00	Commissioners, deputies, or county auditor.	Aliens not permitted to hunt.
Resident.....	1.00	do.....	
Ohio:			
Nonresident.....	15.25	Clerk county court or town clerk.	
Resident.....	1.25	do.....	
Oklahoma:			
Nonresident.....	15.00	Warden, deputy, or county clerk.	All game except deer, turkey, or prairie chicken. Expires May 1. Do.
Alien.....	25.00	do.....	
Resident citizen.....	1.25	do.....	
Oregon: ²			
Nonresident.....	10.00	County clerk.....	
Alien.....	25.00	Commission.....	Gun license. Does not permit hunting.
Resident.....	1.00	County clerk.....	Hunting.
Pennsylvania:			
Nonresident.....	10.00	County treasurer.....	Aliens not permitted to hunt.
Resident.....	1.15	County treasurer or justice of peace.	
Rhode Island:			
Nonresident ³	10.15	City or town clerk.....	
Alien.....	15.15	do.....	
Resident.....	1.15	do.....	
South Carolina:			
Nonresident and alien.....	15.25	County clerk.....	All game.
Resident ⁴	1.10	County clerk or game warden.	County license. Hunting on land of another in county of residence permitted under written permission.
Do.....	3.00	do.....	State license.
South Dakota:			
Nonresident.....	25.00	Warden or county treasurer.	Big game and game birds. Expires June 30.
Do.....	15.00	do.....	Game birds only.
Resident.....	5.00	County treasurer.....	County license. Big game.
Do.....	1.00	do.....	Game birds.
Tennessee:			
Nonresident.....	10.00	County clerk.....	County license.
Resident.....	1.00	do.....	State license.
Do.....	2.00	do.....	
Market hunting.....	25.00	do.....	Annual license; \$200 bond required.
Texas:			
Noncitizen.....	15.00	Commissioner.....	Expires Sept. 1.
Resident.....	1.75	County clerk.....	Do.
Utah:			
Nonresident.....	5.00	Commissioner, deputy, or justice of peace.	Hunting and fishing. Not required for rabbits.
Alien.....	15.00	do.....	Do.
Resident.....	1.25	do.....	Hunting and fishing. Not required for hunting rabbits, or of women.

¹ Issued in the following 58 counties: Beaufort, Bertie, Cabarrus, Camden, Carteret, Caswell, Catawba, Cherokee, Chowan, Clay, Cleveland, Currituck, Dare, Davidson, Davie, Duplin, Forsyth, Franklin, Gaston, Gates, Graham, Granville, Halifax, Harnett, Henderson, Hertford, Hyde, Jackson, Johnston, Jones, Lincoln, Macon, Madison, Martin, Mitchell, Montgomery, Nash, Pamlico, Pasquotank, Pender, Perquimans, Pitt, Polk, Randolph, Richmond, Sampson, Stanly, Stokes, Swain, Transylvania, Tyrrell, Union, Vance, Washington, Wayne, Wilkes, Wilson, Yadkin. Special license provisions are in force in Alexander, Caswell, Clay, Craven, Dare (wild fowl), Haywood, Hoke, Jackson, Lincoln, Northampton, Onslow, Pamlico, Pender, Robeson, Warren and Yancey Counties. Details of these are given in Poster No. 33, copies of which may be had free on application to the Biological Survey, U. S. Department of Agriculture.

² *Oregon:* Veterans of the Civil War pay no fee for license; women not required to obtain license.

³ *Rhode Island:* Nonresident citizens and members of hunting or fishing clubs incorporated prior to Jan. 1, 1909, owning real estate to the value of \$1,000, and nonresident citizens owning real estate assessed at not less than \$500, pay a fee of \$1.15.

⁴ *South Carolina:* Resident licenses only required in following 17 counties: Barnwell, Beaufort, Calhoun, Charleston, Chester, Darlington, Dillon, Dorchester, Florence, Greenville, Hampton, Jasper, Laurens, Lexington, Marion, Oconee, and Orangeburg.

*Details of hunting and shipping licenses—Continued.***UNITED STATES—Continued.**

State and kind of license.	Fee.	By whom issued.	Details of license.
Vermont:			
Nonresident ¹	\$10.50	Town clerk.....	Hunting and fishing. Expires Apr. 1.
Resident.....	1.00	do.....	Do.
Do.....	.60	do.....	Hunting and fishing.
Virginia: ²			
Nonresident ³	10.00	County clerk.....	Good in open season in the 6 months following issue.
Washington:			
Nonresident.....	10.00	State auditor.....	State license. Expires Mar. 1.
Do.....	5.00	County auditor.....	County license.
Alien.....	15.00	State auditor.....	Gun license. Consular certificate required. ⁴
Resident.....	5.00	do.....	State license.
Do.....	1.00	County auditor.....	County license.
West Virginia:			
Nonresident.....	16.00	County clerk.....	State license. Aliens not permitted to hunt.
Resident.....		do.....	No fee. County license.
Do.....	3.00	do.....	State license. Required outside county of residence.
Wisconsin: ⁵			
Nonresident.....	25.00	Secretary of state.....	All game.
Do.....	10.00	do.....	All game except deer
Resident.....	1.00	County clerk.....	
Wyoming:			
Nonresident or alien.....	50.00	Justice of peace, assistant warden, or deputy.	Hunting and fishing.
Nonresident.....	10.00	do.....	Bears only.
Do.....	5.00	do.....	Birds and fish.
Alien.....	5.00	do.....	Birds only.
Resident ⁶	2.50	Justice of peace or game warden.	Ordinary.
Do.....	10.00	do.....	1 additional elk. Issued to holder of ordinary resident license.
Do.....	1.00	do.....	Birds only.
Guide ⁷	10.00	Justice of peace.....	
Alien.....	25.00	do.....	Gun and fishing license. Not required of holder of \$50 alien hunting license, bona fide residents, or freeholder paying taxes in excess of \$100.

¹ *Vermont:* Fee, 60 cents if applicant pays taxes on improved real estate in Vermont appraised at \$1,000.² *Virginia:* Rappahannock County requires written and duly acknowledged permission (good for 4 months) before permitting hunting or trapping on another's land.³ Guests not required to procure license to hunt on land of host, provided the host receives no compensation, directly or indirectly, from such guest and hunts with him.⁴ *Washington:* Holder may then secure \$1 county hunting and fishing license or a \$5 State license.⁵ *Wisconsin:* Bona fide settler who has not resided in the State 1 year may take out a special resident license. Holder of nonresident special license may obtain general license on payment of \$15 additional.⁶ *Wyoming:* Applicant must be an elector of the State; a child or ward, over 15 years, of an elector; a soldier or sailor of the United States and an elector thereof, stationed 1 year at a post in the State; or a nonresident paying \$100 or more taxes on property owned in the State; or an officer employed in the State by the National Forest Service. Soldier or sailor must employ guide.⁷ Guide must be citizen and qualified elector of State, a freeholder or have a valid filing on public lands in the State, must act as assistant game warden, and make sworn report to game warden; required to furnish \$500 bond.

Details of hunting and shipping licenses—Continued.

CANADA.

State and kind of license.	Fee.	By whom issued.	Details of license.
Alberta:			
Nonresident.....	\$25.00	Minister of agriculture.....	General.
Do.....	5.00	do.....	Birds only.
Guide, camp help.....	5.00	do.....	Resident maximum fee. Camp help shall not guide.
Resident ¹	2.50	do.....	Big game.
Do.....	2.25	do.....	Birds. Required south of lat. 55°.
Do.....	1.00	do.....	Required of residents of city or town.
Market hunting.....	5.00	do.....	
British Columbia:			
Nonresident.....	100.00	Warden or any Government agent.	Members of Army, Navy, or Militia in actual service exempt.
Do.....	50.00	do.....	Birds only. Good Sept. 1–Mar. 31.
Do.....	25.00	do.....	Bears only. Good Jan. 1–July 15.
Do.....	5.00	do.....	Birds only. British subject. Good for 1 week.
Resident.....	2.50	do.....	Birds and deer only.
Do.....	5.00	do.....	Birds and all big game.
Do.....	10.00	do.....	Birds, all big game, and trapping.
Guide.....	5.00	do.....	
Manitoba:			
Nonresident.....	50.00	Minister of agriculture.....	
Do.....	15.00	do.....	British subject.
Resident.....	4.00	do.....	Big game only.
Do.....	1.00	do.....	Birds only.
New Brunswick:²			
Nonresident.....	50.00	Minister of lands and mines	Moose, caribou, and deer.
Do.....	25.00	do.....	Game birds. Special license for Westmorland County.
Do.....	10.00	do.....	2 deer only. Discretionary with surveyor general.
Do.....	10.00	do.....	Game birds.
Resident.....	3.00	do.....	Moose, caribou, and deer.
Sinkbox.....	1.00	do.....	For geese and brant.
Guide.....	1.00	do.....	Resident accompanying anyone hunting big game.
Camp help.....	1.00	do.....	Resident.
Do.....	50.00	do.....	Nonresident.
Newfoundland:			
Nonresident.....	51.00	Game and fisheries board..	Can not employ unlicensed guide.
Guide.....	50.00	do.....	Nonresident. Resident guide licenses free.
Resident.....	5.00	do.....	3 caribou not for traffic.
Householder.....		do.....	Do.
Nova Scotia:³			
Nonresident.....	30.00	Provincial secretary, game commissioners, or county clerk.	All game. Expires Aug. 1.
Do.....	15.00	do.....	Birds and small game, except woodcock and snipe.
Alien.....	5.00	do.....	Required of aliens who have not resided in Province for 5 years.
Resident.....	5.00	do.....	For caribou outside county of residence.
Guide.....	2.00	do.....	Resident. Expires Aug. 1.
Ontario:			
Nonresident.....	50.00	Superintendent of game...	All game.
Do.....	25.00	do.....	Ducks and other small game.
Resident.....	5.00	do.....	Moose and caribou.
Do.....	2.00	do.....	Deer.
Guest.....		do.....	No fee required. Good for 1 week or less.
Guide.....	2.00	do.....	
Prince Edward Island:			
Nonresident.....	15.00	Game inspector or tax collector.	All game. Expires 1 year after date. If applicant pays taxes on real estate to the value of \$325, fee \$5.

¹ *Alberta:* Farmers or their sons residing on own land, fee \$1; bird license not required of farmer or member of family residing with him upon his farm, or of residents residing north of lat. 55°.

² *New Brunswick:* Nonresident hunting big game must be in charge of a registered guide.

³ *Nova Scotia:* Nonresident hunting big game must be in charge of a registered guide. Nonresident paying taxes on real estate to the amount of the license fee, required to pay only \$5.

Details of hunting and shipping licenses—Continued.

CANADA—Continued.

State and kind of license.	Fee.	By whom issued.	Details of license.
Quebec:			
Nonresident.....	25.00	Minister of colonization....	All game.
Do.....	10.00	do.....	Issued to members of incorporated hunting clubs.
Resident.....	1.00	do.....	Big game. Not required of person hunting for own use.
Do.....	5.00	do.....	3 deer and 3 caribou additional to bag limit.
Saskatchewan:			
Nonresident.....	50.00	Minister of agriculture....	Big game only.
Do.....	25.00	do.....	Birds only.
Do.....	10.00	do.....	Birds only. Good for 6 days.
Resident.....	5.00	Minister or agent.....	Big game.
Do.....	1.00	do.....	Birds only. Required of resident of city or town.
Yukon:			
Nonresident.....	100.00	Commissioner or game guardian.	All game.

OFFICIALS FROM WHOM STATE GAME LAWS MAY BE OBTAINED.

- Alabama:**
State game and fish commissioner, Montgomery.
- Alaska:** The governor, Juneau.
Secretary of Agriculture, Washington, D. C.
- Arizona:**
State game warden, Phoenix.
- Arkansas:**
Secretary, game and fish commission, Little Rock.
- California:**
Executive officer, fish and game commission, Mills Building, San Francisco.
- Colorado:**
State game and fish commissioner, Denver.
- Connecticut:**
Secretary, commission of fisheries and game, Hartford.
- Delaware:**
Chief game warden, Dover.
- District of Columbia:**
Supt. Metropolitan Police, Washington, D. C.
- Florida:**
Secretary of state, Tallahassee.
- Georgia:**
Game and fish commissioner, Atlanta.
- Idaho:**
Fish and game warden, Boise.
- Illinois:**
Game and fish commission, Springfield.
- Indiana:**
Commissioner fisheries and game, Indianapolis.
- Iowa:**
State fish and game warden, Spirit Lake.
- Kansas:**
State fish and game warden, Pratt.
- Kentucky:**
Executive agent, game and fish commission, Frankfort.
- Louisiana:**
Conservation commission, New Orleans.
- Maine:**
Commission of inland fisheries and game, Augusta.
- Maryland:**
Game warden, 510 Garrett Building, Baltimore.
- Massachusetts:**
Chairman, commissioners of fisheries and game, State House, Boston.
- Michigan:**
Commissioner game, fish, and forest-fire department, Lansing.
- Minnesota:**
Game and fish commissioner, St. Paul.
- Mississippi:**
Secretary of state, Jackson.
- Missouri:**
Game and fish commissioner, Jefferson City.
- Montana:**
State game warden, Helena.
- Nebraska:**
Game and fish commissioner, Lincoln.
- Nevada:**
Secretary of state, Carson City.
- New Hampshire:**
Fish and game commissioner, Concord.
- New Jersey:**
Secretary board of fish and game commissioners, Trenton.
- New Mexico:**
Game and fish warden, Santa Fe.
- New York:**
Secretary conservation commission, Albany.
- North Carolina:**
Secretary Audubon Society of North Carolina, Raleigh.
- North Dakota:**
Secretary game and fish board, Fargo.
- Ohio:**
Chief game warden, Board of Agriculture, Columbus.
- Oklahoma:**
State game warden, Oklahoma City.
- Oregon:**
State game warden, Portland.
- Pennsylvania:**
Secretary board of game commissioners, Harrisburg.
- Rhode Island:**
Commissioner of birds, Rumford.
- South Carolina:**
Chief game warden, Columbia.
- South Dakota:**
State game warden, Pierre.
- Tennessee:**
State game and fish warden, Nashville.
- Texas:**
Game, fish, and oyster commissioner, Austin.
- Utah:**
Fish and game commissioner, Salt Lake City.
- Vermont:**
Fish and game commissioner, Lyndonville.
- Virginia:**
Secretary of state, Richmond.
- Washington:**
Chief game warden and State fish commissioner, Seattle.
Chief deputy game warden, Spokane.
- West Virginia:**
Forest, game, and fish warden, Belington.
- Wisconsin:**
Secretary conservation commission, Madison.
- Wyoming:**
State game warden, Lander.

CANADA.

- Alberta:**
Chief game guardian, Edmonton.
- British Columbia:**
Provincial game warden, Vancouver.
- Manitoba:**
Chief game guardian, Winnipeg.
- New Brunswick:**
Minister of lands and mines, Woodstock.
- Newfoundland:**
Secretary department of marine and fisheries, St. Johns.
- Nova Scotia:**
Chief game commissioner, Halifax.
- Ontario:**
Superintendent game and fisheries, Toronto.
- Prince Edward Island:**
Game inspector, Charlottetown.
- Quebec:**
General inspector of fisheries and game, Quebec.
- Saskatchewan:**
Chief game guardian, Regina.
- Yukon:**
Territorial secretary, Dawson.



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BUR CLOVER.

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INTRODUCTION.

Bur clovers are annual legumes, much like ordinary clovers, but the small yellow flowers are in clusters of 5 to 10, and the coiled pods are commonly beset with spines, thus forming the so-called bur. The roots are fibrous and do not extend very deep. Most of the plants are branched at the crown with 10 to 20 or more spreading or decumbent branches 6 to 30 inches long, which in fruit are thickly beset with the burs. Well-developed plants may contain more than 1,000 pods. Bur clovers are valuable agriculturally only where the winters are mild enough for them to withstand them. In the United States this embraces the cotton-growing area of the South and all of the Pacific coast west of the Cascade and Sierra Nevada Mountain Ranges.

There is a growing appreciation of the value of bur clover, from the fact that it so readily maintains itself with little or no reseeding

and because each year it can be depended upon to add humus and nitrogen to the soil without sacrificing the regular summer crop of the farm. For the South especially, bur clover is the cheapest legume that serves as a winter cover crop, thus preventing the washing of the soil. In addition to its value as a winter cover crop, it furnishes some pasturage and improves the soil. By the use of bur clover alone many instances are reported where the cotton crop has been materially increased each season.

KINDS OF BUR CLOVER.

There are two kinds of bur clover cultivated in the United States, namely, the spotted or southern bur clover (*Medicago arabica*;

fig. 1) and the toothed or California bur clover (*Medicago hispida denticulata*; fig. 2). The spotted or southern bur clover may be readily distinguished by the purple spot in the center of each leaflet. The pods of the two species are also quite distinct, as shown in figures 3 and 4. A pod of spotted bur clover contains from two to eight seeds, while in toothed bur clover the usual number is three, but often as many as five. At the present time only these two species of bur clover are of importance in American agriculture. There



FIG. 1.—Spotted bur clover (*Medicago arabica*).

are in addition about 35 other species, some of which have large and smooth burs, while others have very hard and spiny burs. All of these are native to the Mediterranean region, although few occur naturally as far eastward as Turkestan. Those with large spineless burs, such as button clover (*Medicago orbicularis*), snail clover (*Medicago scutellata*), and tubercled clover (*Medicago tuberculata*), are being tested at the present time to determine their value for this country. There

is also a variety of the spotted bur clover with spineless pods and a similar variety of the toothed bur clover. Thus far it does not appear that there is any great advantage in these spineless forms.

CLIMATIC ADAPTATIONS.

All of the bur clovers are normally winter annuals; that is, in the country to which they are native they germinate in the autumn, grow during the fall, winter, and early spring, and mature early in summer. They are thus primarily adapted to regions with mild, moist winters, and in this country they maintain themselves naturally only in the areas shaded on the accompanying map (fig. 5). Northward from the areas indicated they succeed fairly well when the seed is sown in the spring, but they are scarcely able to maintain themselves by reseeding from year to year.

On the Pacific coast, especially in California, spotted bur clover is now nearly as abundant as toothed bur clover and seems equally well adapted to the natural conditions. In the Southern States spotted bur clover is decidedly better adapted to the conditions than toothed bur clover.



FIG. 2.—Toothed bur clover (*Medicago hispida denticulata*).

The latter, however, appears able to maintain itself well from year to year in portions of the cotton belt, especially in the less humid portions of Texas. There is also good evidence to indicate that toothed bur clover is destroyed in winter by cold that does little or no harm to the southern bur clover. The latter, therefore, is to be preferred in the cotton States, where toothed bur clover can not be so highly recommended.

Bur clover may be pastured in North Carolina by the middle of February, and near the Gulf coast it furnishes practically continuous

winter pasturage. No other cultivated legume will make more growth during cool weather in this area.

SOIL PREFERENCES.

Bur clover will succeed in practically all types of soil, but loams are most suitable. In the South the plants grow best in soils rich in lime, but thrive well enough in soils poor in this substance. On the Pacific coast, even where the soils are poor in lime, bur clover grows vigorously. Apparently the plant is not indifferent to lime, but it will succeed in noncalcareous soils. As a rule it prefers moist well-drained soils, but in California it grows vigorously in adobe



FIG. 3.—Pods of spotted bur clover.



soils, which are often poorly drained. Where the soil is very moist the plants mature much later than on well-drained land. The California Agricultural Experiment Station found that toothed bur clover would grow luxuriantly in alkali soil containing 11,300 pounds of carbonate of soda to an acre in the top 30 inches of soil. The plant is therefore apparently as tolerant of alkali as barley. In general, bur clover succeeds well in slightly alkaline soils but not in those heavily charged with salts.

TIME OF SEEDING.

Bur clover should always be sown in late summer or fall. In the cotton States the best time of seeding is the month of September, but it may be seeded in August, and seedings as late as December often give favorable results, even as far north as South Carolina. Late seedings, however, are to be avoided whenever possible, as but little fall and winter growth is secured from such plantings. Hulled seed germinates more readily than seed in the bur, so that where hulled seed is used the time of sowing may be delayed on the average from two to four weeks longer than if seed in the bur is used.



FIG. 4.—Pods of toothed bur clover.



In California, where the summers are always dry, seeding may be delayed until just before the fall rains begin. If the sowings are to be made on irrigated land, the best average date is about the first of October, as by seeding at this time only a single irrigation is ordinarily necessary; that is, the one made just before seeding. If the

eeding is done earlier a second irrigation may be necessary before the rains come, as otherwise the young plants are quite sure to be injured by drought.

SOWING THE SEED.

Hulled seed may be sown by a grain drill with a press-wheel attachment, or by any method of broadcasting, using about 15 pounds of seed per acre. A firm seed bed is desirable, and especial care should be taken to cover the seed thinly. Under most conditions broadcasting will be found most satisfactory, but the seed should be covered with a light harrow. Where moisture conditions are entirely favorable good stands have frequently been obtained by merely scattering the seed on the surface, but whenever practicable harrowing is recommended.

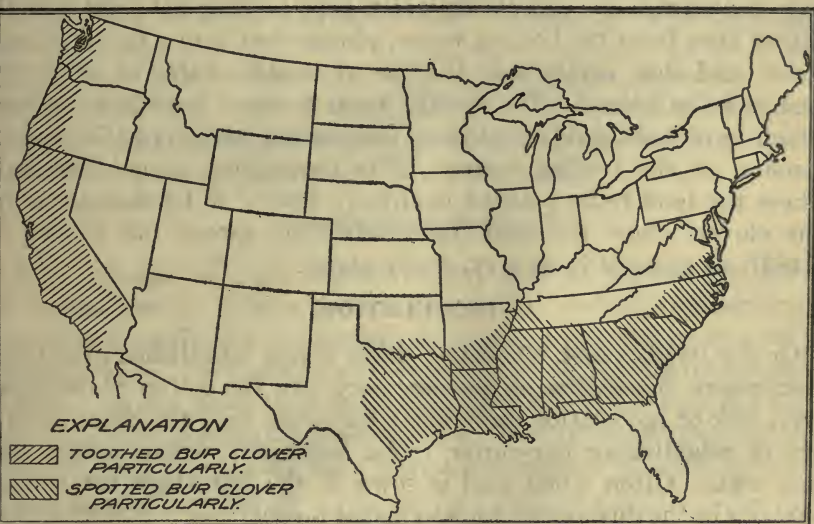


FIG. 5.—Outline map of the United States, showing the regions to which bur clover is adapted.

When the seed is sown in the bur, broadcasting is the only practicable method. To obtain a full stand by this method, from 3 to 6 bushels of seed per acre are necessary, followed by a harrowing.

In the regions, however, which are well adapted to bur clover it is much more economical as a rule to begin with a light seeding and to depend in subsequent years on the volunteer crop, where this is practicable.

GERMINATION OF THE SEED.

Good seed of the bur clovers retains its vitality for a number of years. In all cases it contains a considerable proportion of hard seeds, most of which do not germinate until the second year. This is particularly true where the seed is sown in the bur, as the bur tends

to keep moisture from reaching the seeds. Partly on account of the hard seeds and partly on account of the protection of the bur, difficulty is often experienced in securing a stand of bur clover.

Independent investigations by McNair,¹ of the Office of Farm Management, and by Duggar and Tisdale,² of the Alabama Agricultural Experiment Station, have shown that this difficulty of germination can be largely overcome by treating the seed in the bur with boiling water before it is sown. As a result of these investigations the following method is recommended: (1) Empty a bag of the burs in a tub of cool water and let them stand for two hours stirring occasionally to loosen as much dirt as possible for re-inoculating the burs at the end of the hot-water treatment; (2) remove the burs from the tub of cool water, put in a bag, and immerse for five minutes in a barrel of water almost scalding hot; (3) plunge the bag of burs for one minute in water kept boiling hot; (4) lift the bag of burs from the boiling water, plunge first into a barrel of cool water, and then empty into the tub of muddy water in which the seed was first placed. The muddy water tends to inoculate the burs which have presumably had their inoculating bacteria killed by immersion in the boiling water. This inoculation is not necessary where the land to be planted is already known to be inoculated for bur clover. Sow the seed immediately or spread out to dry as rapidly as possible in an airy, shady place.

INOCULATION.

On the Pacific coast, where bur clover is now established practically everywhere, inoculation is not necessary. In the cotton States, however, lack of inoculation apparently has often been the cause of failure in establishing bur-clover crops, especially where hulled seed was sown. Often when seed is sown in the bur there are enough bacteria in the dust on the burs to insure inoculation. It is desirable however, in planting bur clover for the first time, that farmers do not go to the expense of purchasing a large quantity of seed, but that they plant a comparatively small area, inoculating the soil either by the soil-transfer method or, in the absence of inoculated soil, by the use of pure cultures. When once a patch of bur clover has been grown successfully on a farm the whole farm can be inoculated by scattering soil from the places where the bur clover grew successfully.

¹ McNair, A. D. Boiling bur clover seed to hasten germination. *In* Prog. Farmer [Raleigh, N. C.], v. 29, no. 38, p. 997. 1914.

² Duggar, J. F., and Tisdale, H. B. Bur clover seed; means of hastening their germination. Ala. Agr. Exp. Sta. Circ. 29, p. 113-116. 1914.

THE SOIL-TRANSFER METHOD.

The soil-transfer method is the surest known way to secure the inoculation of any legume. The soil should be taken from a spot where bur clover is growing successfully or from fields of alfalfa, yellow clover, or melilotus. The same germ inoculates all four of these plants, so that soil from near the roots of any one will inoculate the others. The soil should be taken from the top 8 inches and broadcasted over the area to be planted at the rate of 500 pounds per acre. Care should always be taken to secure soil free from troublesome weeds or diseases.

On account of the expense involved it is seldom advisable to get large quantities of soil from a distance. It is better to sow but a small patch the first year, which, if successful, will supply abundant soil to use as inoculation for more extensive plantings.

Sometimes inoculation is secured by dusting the seed with well-inoculated soil.

Even if a little seed is sown without inoculation, especially if the seed be in the bur, some of the plants are quite sure to have nodules on their roots. In this manner large areas of land may be gradually inoculated at merely the expense of a little seed.

PURE-CULTURE METHOD.

Pure cultures in glass containers may now be secured for nearly all legume crops. Where these are used, it is strongly recommended that only a small area be planted at first, and preferably on good or manured soil. Pure cultures frequently fail to provide inoculation, so that a farmer should not depend on them alone when sowing large fields of a new legume for the first time. Where soil is not available, however, they furnish the most convenient method of securing inoculation in small plantings.

VOLUNTEER CROPS OF BUR CLOVER.

One of the peculiarities of bur clover over most other legumes is the fact that good stands can often be obtained from year to year without additional seeding. On pasture lands, where once established, bur clover will reseed itself indefinitely.

On cultivated land the same thing is true, provided the land is not plowed until some of the burs have ripened. For most summer crops it is impracticable to allow the bur clover to remain on the land so long. This is particularly true of corn and of cotton. Even with these crops a stand for the succeeding fall is sometimes secured by leaving balks in plowing; that is, leaving rows of the bur clover unturned until the plants have ripened their pods. This, however,

necessitates leaving about every tenth row of the old cotton or corn field unplowed until the bur clover is mature, though fewer balks will suffice if the ripened burs are gathered and scattered. When the pods are mature the dried plants should be turned under rather shallow, as, if the seeds are buried deep, the stand will probably be thin. On the whole, however, it is better to grow the bur-clover seed in a separate patch, gather it when ripe, and then sow in the cultivated crop where desired. Under some conditions bur-clover seed will retain its vitality in the soil for two or three years, so that where once well established volunteer stands are common.

BUR CLOVER FOR PASTURES.

Bur clover is mostly utilized as pasture for hogs, cattle, sheep, and poultry. Horses and mules ordinarily refuse to eat it. Even other farm animals do not eat it readily at first, but soon acquire a taste for the plant and then eat it greedily. In Argentina, where both the toothed bur clover and the spotted bur clover occur, it is said that horses will eat the former quite readily but absolutely avoid the latter. No similar observations have been recorded for California where both of the species grow together. When bur clover is growing in cultivated lands it is best not to pasture continuously, but to put the stock on the land for only a few hours each day, as this reduces very much the injury by trampling. Few cases have been recorded of bur clover causing bloating to animals, but where the growth is lush care should be exercised. Not only do animals eat the herbage, but sheep especially are very fond of the ripe pods and will lick these up from the ground. Much of the value of range lands in California depends on the large crop of pods produced by the bur clover, which remain in good condition a long time. When the burs are abundant in the pasturage sheep fatten very rapidly. The spines bother the animals but little, but the burs are eaten more readily when they have been softened by the rain.

For permanent pastures in the South a combination of bur clover and Bermuda grass is very satisfactory. The Bermuda grass furnishes pasturage during the warm weather until further growth is stopped by frost, while the bur clover begins to grow with cool weather in the fall and provides pasturage during the winter and spring. Where once established on such pastures it reproduces itself continuously. On Bermuda pastures where bur clover is not established it is recommended that furrows be plowed through the Bermuda grass from 5 to 10 feet apart and seed of bur clover, preferably in the bur, be sown in these plowed furrows in September. Within a year or two the plants that are produced in these plowed furrows will seed the whole pasture. Disking such a pasture in summer tends to stimulate

the Bermuda grass. Broadcasting about 1 bushel of bur-clover seed in the bur to each acre before disking the Bermuda grass will usually give a stand of the bur clover.

USE AS A COVER AND GREEN-MANURE CROP.

Bur clover alone is commonly used as a green-manure crop in the orchards of California and is often so handled that good volunteer crops are obtained year after year.

In the South, undoubtedly the greatest value of bur clover is due to the fact that it is the cheapest and most easily handled legume that can be used as a combination cover and green-manure crop. Even where it makes a small growth of only a few inches in height, this is sufficient to prevent to a large degree the washing of the land in winter and when plowed under to add sufficient humus and nitrogen to improve materially the following cotton crop. It is the most economical legume to use for this purpose, as when once a stand has been secured and rows of the plants are left to seed it will volunteer from year to year. The same method can be used with corn or any other intertilled summer crop. There is some difficulty in seeding bur clover in standing cotton, as in the harrowing of the bur-clover seed some of the ripe cotton is pulled out of the bolls. On this account the harrowing should be done just after the pickers have been through the field, to avoid as far as possible any injury to the opened bolls.

There are several well-authenticated farm records which show that by the simple use of bur clover in rotation with cotton the yields of cotton have shown marked increase year after year. There is apparently no other legume as satisfactory as bur clover for this purpose. The use of a summer legume crop, like cowpeas or soy beans, is advisable in good rotations, but where cotton is grown continuously it involves the omission of this crop for an entire growing season. Furthermore, when the cowpeas are plowed under, a larger amount of vegetable matter is often added to the soil than is good economy, and it is practicable to do this only at long intervals. It is much cheaper and much more satisfactory to use bur clover, which, after it is once established, does not involve much expense for growing seed, nor does it require the loss of a growing season, as is the case with a summer legume crop. Furthermore, it adds each year a reasonable amount of humus and nitrogen, which in the end gives much more satisfactory results than the turning under of a large green-manure crop at long intervals. Perhaps no one thing will tend to bring about an increased yield from cotton fields more surely and more cheaply than the general use of bur clover to make winter cover and green-manure crops.

VALUE FOR HAY.

Under favorable conditions bur clover will make a dense stand 1 to 24 inches high. From such dense stands of bur clover, yields of 2 or even 3 tons of hay per acre have been recorded. Unless the stand is very dense, however, bur clover plants lie close to the ground, so as to make mowing very difficult. If bur clover is to be grown for hay, it is preferably sown in mixture with oats or wheat, as with these grain crops the bur-clover plants tend to grow erect. Ordinarily about 5 bushels of bur-clover seed in the bur should be sown to the acre, together with 2 bushels of winter oats or $1\frac{1}{2}$ bushels of wheat. For growing in this manner, however, hairy vetch is much to be preferred to bur clover, and even crimson clover will ordinarily give larger yields under such conditions than bur clover. Bur clover hay does not enjoy a high reputation, but comparatively little of this clover is ever utilized as hay.

ROTATIONS.

Bur clover may be used as a winter crop in rotation with any cultivated summer crop, as before mentioned. Among rotations that have been suggested the following seems desirable:

First year: Cotton; bur clover sown between the rows September 1.

Second year: Corn or soy beans, followed by bur clover.

Third year: Cotton.

A less simple rotation is the following:

First year: Cotton; bur clover sown between the rows September 1.

Second year: Corn, followed by winter oats.

Third year: Oats, followed by soy beans or cowpeas, preferably in rows. Bur clover sown in the rows September 1. If the soy beans or cowpeas are broadcasted, the bur clover should not be sown before the crop is harvested.

Fourth year: Cotton.

After the clover is once well established, stands of bur clover can generally be secured in such intertilled summer crops as cotton, corn, soy beans, or sorghums. In broadcasted crops, however, such as soy beans, millet, and cowpeas, the shade is so dense that the young bur-clover plants for the most part perish.

The common use by the Chinese of bur clover as a winter green manure crop to grow in rotation with rice is also worthy of notice. To a slight extent bur clover has thus been used in rotation with rice in Louisiana, but there is every reason to believe that its employment in this manner would prove to be profitable, as the long experience and practice of the Chinese indicate.

The remarkable adaptation of bur clover for use in rotations is due to the fact that it can be seeded with little or no preparation of

the land, provided only that the proper inoculating germs are present in the soil. The only handicap to its general use in this manner, especially where seeding each fall may be necessary, as would be the case with rice, is that it involves a larger and cheaper supply of seed than has yet been available.

GROWING AND HARVESTING SEED.

TOOTHED OR CALIFORNIA BUR CLOVER.

Most of the commercial seed of toothed bur clover comes from California. Much of the seed is harvested as an impurity with wheat and other grain crops, from which it is separated at the mills and warehouses handling grain. On account of the increased demand in recent years, various methods have been used to harvest bur-clover seed directly from pasture lands where there is practically a pure stand and where the burs are produced in abundance. The simplest method is sweeping by hand with large stiff brooms. Among machines that have been used are ordinary mowers, self-rake reapers, combined harvesters, and specially devised suction machines. When the mower, reaper, or harvester is used, the crop must be cut before all the seeds are ripe, as the burs ripen unevenly and drop readily when ripe. As a consequence, a good deal of green material is harvested with the burs, which necessitates careful drying to prevent damage by heating and sweating. Furthermore, on account of the half-prostrate habit of the plants a large part of the crop is left on the ground.

The power suction machine saves all the seed, but the cost of operation is high. When this machine is used the burs are allowed to become perfectly dry, so that they are easily lifted from the ground by air suction.

The method most employed when but a small quantity of seed is to be saved is that of hand sweeping. When this method is used the seed is allowed to ripen thoroughly, and then the vines are cut with an ordinary mowing machine and raked into windrows. The burs are then swept together with large barn brooms and hauled from the field. The burs gathered in this manner are mixed with more or less gravel and other foreign substances, which must be removed before the seed can be satisfactorily hulled or used in the bur. This separation is accomplished by the use of handbarrow screens and an ordinary fanning mill regulated to blow the burs over; or, if running water is handy, a quicker and more satisfactory method is to throw the burs into the water. All heavy substances sink, and the burs and lighter substances are dipped from the stream. To facilitate this method of separation the channel of the stream should be narrowed in the shape of an open V, which aids greatly in collecting

the clean burs. To dip the burs from the water, a large handbarrow with a bottom made of wire netting has been found very satisfactory. The burs are spread on canvas to dry, after which they are ready for the huller. The burs can be successfully hulled with an ordinary clover huller.

A second source of the seed of toothed bur clover, often mixed with spotted bur clover, has been from the burs removed from wool. Bur clover of one or both species is abundant in Argentina and also in Australia, as well as in the Mediterranean countries. The quantity of these burs contained in wool is so large that it has been found profitable to save the seed in European wool-cleaning mills.



FIG. 6.—Seeds of spotted bur clover.

SPOTTED BUR CLOVER.

Practically all of the commercial seed of spotted bur clover is grown in the cotton States, and the supply has usually been much below the demand. Thus far the seed has been marketed only in the bur, but there seems no good reason why clean hulled seed should not be produced in commercial quantities. Hulled seed is much more easily sown, and once the land is inoculated the regular seeding of bur clover in cotton would replace to a large degree the dependence on volunteer crops.

Raking or sweeping the ripened pods from the ground is the only method used in harvesting spotted bur-clover seed. When the pods are not perfectly dry, care must be exercised in curing, as otherwise the piles will heat, with consequent injury to the seeds. It is probably due to such heating that the commercial seed so often shows low germination.

Every southern farmer can easily grow his own supply of bur-clover seed at small expense. This is especially recommended at the present time, when the commercial supply of seed is inadequate.



FIG. 7.—Seeds of toothed bur clover.

YIELD AND WEIGHT OF SEED.

Bur-clover seed closely resembles that of alfalfa. Formerly much of it was used to adulterate alfalfa seed, but this practice is now rare due to the enforcement of pure-seed laws. The two kinds of bur clover may be distinguished by their seeds (figs. 6 and 7) as well as by their burs.

TOOTHED BUR CLOVER.

The average yield in California is from 300 to 500 pounds of hulled seeds per acre. This seed weighs about 60 pounds to the bushel. One bushel of clean, dry burs weighs 6 to 12 pounds and contains 2 to 4 pounds of seed.

SPOTTED BUR CLOVER.

From a good stand the average yield of burs per acre in the South is about 500 pounds, but yields of 1,200 or even 1,500 pounds per acre are recorded. One bushel of spotted bur-clover seed in the bur weighs from 6 to 14 pounds. A hundred pounds of the clean burs contain 30 pounds of seed. The yield of clean seed per acre is therefore 150 to 360 pounds, or about half the yield of toothed bur clover secured in California.

CHEMICAL ANALYSES.

The chemical analysis of a forage plant is valuable mainly as it indicates close similarity to another plant whose feeding value is comparatively well known. It will be noted that the composition of bur clover is very similar to that of alfalfa, but there is less fiber and somewhat more fat (ether extract) and protein, all of which are favorable differences. In all probability the feeding value of bur clover is practically the same as that of alfalfa. Analyses of bur clover made at the agricultural experiment stations of seven States, compared with analyses of green alfalfa and alfalfa hay, are shown in Table I.

TABLE I.—*Chemical analyses of bur clover.*

[Compiled by G. L. Bidwell, Bureau of Chemistry.]

Reference data. ¹	Moisture in original sample.	Reduced to a dry-matter basis (per cent).				
		Ash.	Ether extract.	Crude fiber.	Nitro- gen-free extract.	Protein.
	<i>Per cent.</i>					
Texas Exp. Sta. Bul. 20.	79.51	12.76	7.73	15.34	38.56	25.61
Do.	73.81	8.89	7.44	22.36	40.09	21.12
Tenn. Agr. Exp. Sta. Bul. 3, vol. 9.	84.32	12.55	10.50	17.21	31.56	28.18
South Dakota Exp. Sta. Bul. 69.	4.82	24.14	2.11	19.90	40.13	13.72
Alabama Exp. Sta. Bul. 165.	7.59	10.70	4.57	27.81	35.82	21.10
Mississippi Exp. Sta. Ann. Rept. 1895.	10.69	3.17	20.77	46.24	19.13	19.13
Do.	11.71	10.23	21.73	32.39	23.94	23.94
Louisiana Exp. Sta. Bul. 19, series 2.	11.15	10.49	4.67	35.74	34.86	14.24
California Exp. Sta. Bul. 125.	8.95	5.49	3.95	33.59	41.98	14.99
Average, 9 samples.		11.93	6.04	23.83	37.97	20.23
Alfalfa, green, 23 samples.	71.8	9.57	3.55	26.24	43.62	17.02
Alfalfa hay, 21 samples.	8.4	8.08	2.40	27.29	46.62	15.61
Average, alfalfa, 44 samples.		8.86	3.00	26.74	45.05	16.35

¹ The analyses of the experiment stations of Alabama, Louisiana, and Mississippi, and probably those of the Texas station, are of spotted bur clover; that of California is in all probability toothed bur clover.

ORGANIZATION OF THE UNITED STATES DEPARTMENT OF AGRICULTURE

October 2, 1926

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THE CULTIVATION OF PEPPERMINT AND SPEARMINT

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Physiologist, Drug and Poisonous Plant Investigations



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THE culture of peppermint and spearmint in this country is centralized in Michigan, Indiana, western Oregon, and New York in a few localities where soil conditions especially favor the development of the plants, but is capable of considerable development in other localities should greater commercial need arise. The total area of mint under cultivation in the States named is estimated at about 17,500 acres, of which nearly 2,000 acres is spearmint.

Mint culture in New York has declined in extent, although still carried on in a small way, chiefly by cooperation between landowners and practical mint growers. In Michigan and Indiana, where there are large areas of fertile muck land susceptible of thorough drainage, mint culture has become highly specialized, a considerable part of the acreage being controlled by a few well-equipped growers who are able to handle the product in an economical manner. Within the last two years, the production of peppermint oil has been developed on a commercial basis in western Oregon.

Mint culture on suitable soils appears to give fair average returns when intelligently conducted from year to year. It is, however, an industry limited in scope, especially subject to fluctuations in prices of the crop products, and likely to suffer from overproduction if the acreage is extended too rapidly.

THE CULTIVATION OF PEPPERMINT AND SPEARMINT.

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EXTENT OF THE INDUSTRY.

The culture of peppermint and spearmint appears to have been introduced into this country by way of the early settled New England States. The volatile oil distilled from these plants is the principal marketable product, although there is a rather limited market for the dried herb, and it is the effort of the producers to secure the best yield of herb and oil with the highest quality consistent with economy in growing and handling the crude material.

Peppermint has always been first in importance, as the oil is widely used for medicinal and flavoring purposes. Spearmint has long been known as a culinary herb for flavoring sauces and cooling drinks, but recently it has come into extensive use as a material for flavoring chewing gum, liqueurs, and confectionery.

For many years the United States has been the greatest producer of peppermint and spearmint oils, and from present indications bids fair to maintain the lead. Japan, Russia, Germany, and England are also considerable producers, the last two countries turning out oils of the highest commercial quality. No accurate statistics of the world's output of these commodities appear to be available, but it is the impression among those best informed that the annual production of oil exceeds 600,000 pounds, of which the United States contributes about 250,000 pounds.

Wayne County, N. Y., was the first locality in which peppermint was grown and distilled on a commercial scale. The year 1816 is assigned as the date when the industry reached mature proportions, and from that time until 1889 it prospered, the area devoted to the

plant at times reaching almost 4,000 acres. Gradually, however, the area decreased, until, according to present advices, probably less than 300 acres are being cropped with both peppermint and spearmint in Wayne and the adjoining counties.

From New York peppermint culture extended to a few of the northern counties of Ohio, and in 1835 a plantation was made in Joseph County, Mich., which proved so successful that the culture soon extended to adjacent counties in southern Michigan and northern Indiana. The area has since increased, and in 1917 it was estimated that there were 17,500 acres of peppermint under cultivation, nearly all of which was in the Michigan-Indiana district. Ohio appears to have fallen out of the race as far as commercial mint culture is concerned, leaving Michigan and Indiana as the main producing centers.

DESCRIPTION OF THE PLANTS.

Peppermint is known botanically as *Mentha piperita*. For distillation purposes two varieties are chiefly grown, the so-called black mint and the white mint. Black mint, which is the variety grown on nearly all the peppermint farms in this country, has dark-purple stems and deep-green, broadly lance-shaped leaves, slightly toothed. The white mint has green stems and light-green leaves, more pointed in form and deeply toothed. The white variety yields the finer quality of oil, but the plant is less hardy and productive than the black mint and is now little cultivated in America, although in parts of Europe it is still a favorite. The domestic stocks of black mint have been from time to time replenished by importations of the finest selected strains from northern Europe, particularly from the famous mint plantations of the Mitcham district in England. When first brought over, these foreign-bred plants are usually disappointing in growth, but after thorough acclimatization they appear to be more vigorous and productive than the common long-naturalized form known in New York as "American" or "State" mint.

The appearance of the ordinary peppermint now found growing in moist places in many localities from Massachusetts to Minnesota as far south to Florida and Tennessee is too well known to warrant a lengthy description. It is a perennial plant with profuse bloom, but it rarely perfects seeds. It increases by abundant runners at or near the surface of the soil. These runners root freely and under favorable circumstances send up new growths at practically every joint or node. The stems are nearly square and grow erect, often reaching 3 feet in height. The numerous lance-shaped leaves, bright or dark green in color according to variety, are provided with many minute oil glands, chiefly on the under surface. The small purplish

flowers are arranged in spikes at the ends of the branches and main stem. The whole plant exhales the well-known peppermint odor, which is greatly increased when the leaves are handled or bruised.

Spearmint (*Mentha viridis*) is a plant of even more vigorous growth than peppermint, reproducing itself by runners in the same manner as peppermint and usually tending to crowd out the latter when the two grow together. The leaves are longer and lighter green in color. The flower spikes are more pointed, and the main stem usually exceeds the branches in length. Spearmint has a distinctive odor and taste, which to most people is much less agreeable than that of peppermint. The oil glands are distributed throughout the plant in the same manner as in peppermint, but are rather less abundant.

CULTURAL REQUIREMENTS.

Peppermint and spearmint thrive best in deep soils which are rich in humus and retentive of moisture but fairly open in texture and well drained, either naturally or artificially. These conditions are more frequently combined in effectively drained swamp lands, such as are used for the special culture of cranberries, celery, lettuce, onions, and other crops for which a strong, rapid growth is desired. Peppermint and spearmint may, however, be commercially grown in well-prepared upland soils, such as will produce good corn or potatoes. For this purpose fertile loams, sandy or gravelly in character and of good texture and depth, should be selected. Light, loose, dry soils and sticky clays are alike unsuitable.

When possible, the area selected should be summer fallowed for one or two years previous to setting out the peppermint or spearmint, or it should be cropped with some plant which requires clean and frequent tillage, in order to free the land from troublesome weeds and grasses. On uplands, such crops as potatoes, late sugar corn, and root crops are generally well suited for this purpose; and on reclaimed marshlands, cabbage, lettuce, or onions may be used. This cultural preparation of the soil usually proves a great economy in the subsequent care of the close-growing mint crops.

UPLAND CULTURE.

Although declining in extent, the upland culture of mint still holds favor in Wayne County, N. Y., as swampy areas in that locality suitable for the purpose are quite limited. In 1914, perhaps 100 acres of new plantings of peppermint, mostly in plats of 3 to 8 acres, were established on upland soils which had been cropped the previous year with potatoes or with vegetables for the canning factories. The plantings seen in the vicinity of Lyons, N. Y., were on "cobble

loam" in good condition, which had been cropped the year before with potatoes or with such vegetables as beets, spinach, and sugarcorn. The plats were prepared early in May by rather deep plowing and thorough harrowing, special effort being made to free the soil from all remaining roots of perennial weeds and grasses. Furrows 3 inches deep and 3 feet apart were opened with a light plow, and runners dug with a potato hook from old plantings were dropped into the furrows, so as to form an almost continuous row.

When setting mint, the planter, carrying a bag on his shoulder, usually walks in the furrow, stepping on the runners as he drops them. He endeavors at the same time by a motion of the foot to cover the runners partially with loose earth, in order to keep the ends, which may be from 1 to 3 feet long, from protruding in such a manner that they might be pulled out by the tools which are used for covering and cultivating. A fair-sized wagonload of runners, weighing a ton or more, is needed to plant an acre properly. The covering is completed with a plow, a wheel hoe, or a cultivator run near the furrows.

A few days after planting it is customary to harrow the plat across the rows with a flexible-fingered weeder or rather light spike-tooth harrow and to repeat the operation at a different angle or direction as often as may be needed to keep the surface mellow and free from weeds. This is continued until the mint is high enough to be injured by the weeder or harrow, after which the tillage is confined to stirring the soil between the rows with a corn cultivator and to such hand weeding between the plants as may be necessary. By midsummer the mint usually so encroaches on the spaces between the rows that cultivation ceases, but hand hoeing and weed pulling continue until the crop is ready for cutting, which is at the time of full bloom. With new mint planting, this usually occurs early in September.

Cutting is done early in the day with a scythe or mower, according to the size of the plat and the condition of the soil. The mint is allowed to lie in the swath until half dry, and the curing is finished in windrows or cocks, as with clover hay. When fairly well dried but before the leaves shatter on handling, it is hauled to the still.

In former years much of the mint was distilled when freshly cut, but it is now generally conceded that the small loss of oil which occurs during the curing process is well offset by the material gain in ease with which the herb is handled, as well as the time saved in distillation. The dry herb is not only less bulky and less heavy than the freshly cut herb, but it is more quickly distilled and requires less steam for the thorough exhaustion of the oil.

In favorable seasons a very abundant second growth of mint occurs after the crop is harvested, but this aftermath is now seldom cut,

it has been found to weaken the roots greatly and to subject them to winterkilling. The usual practice is to plow down this second growth after it has been killed by frost, turning it under about 3 inches. This apparently harsh treatment breaks up the clumps, buries the surface runners, and is thought to give a better stand than when the plants are fully exposed to the weather. The fertilizing effect of the herbage when buried is also greater than when it is permitted to decay on the surface.

The fall plowing of mint is now quite universal on all types of soil, the depth of turning under ranging from 3 inches in the heavier loams to 5 inches in loose muck. Before growth starts in the following spring, the surface of the soil is loosened with a spike-tooth harrow, and cultivation is continued until the sprouts are tall enough to be injured, after which the cultivator is used in the rapidly narrowing spaces between the rows. In the second and third years, because of the thicker stands, more handwork is needed to suppress weeds and grasses. As a rule, the crops of the second and third years are ready to cut two or three weeks earlier than new plantings and should be somewhat heavier, though the oil yield is seldom materially greater. In the second season, the aftermath is plowed under after frost, as in the preceding year, and similar cultivation is given the third year, after which the mint is deeply plowed under. The field is then well fertilized and seeded with winter grain or is devoted to some succession crop that will keep the land clean and in good condition. Rarely does the stand remain good enough for a fourth crop of mint.

In seasons of good oil prices, the grower may find it profitable to distill the second growth of mint in old stands that are to be abandoned, but the old fields are more often used as a source of runners and propagating roots for new plantings and in consequence are not cut over in the fall.

Upland mint culture is now practically confined to the New York district, as the abundance of suitable muck land in Michigan and Indiana precludes the necessity for using the fertile uplands in those States for the purpose. In Wayne County, N. Y., the mints are frequently grown in cooperation, one party furnishing the land and team labor and another the required tillage. After distillation a division of the oil is made.

MUCK-LAND CULTURE.

In southern Michigan and northern Indiana there are many broad, level areas, often several thousand acres in extent, of deep and fertile muck soil, the beds of ancient lakes and swamps, where the remains of ages of growths of aquatic vegetation have accumulated. These swamps and marshes have been reclaimed by drainage and plowing

and by subduing the native vegetable growths until the fine black soil, with its high percentage of humus and available plant food, is especially fitted for the cultivation of a variety of useful crops. Peppermint and spearmint find these deep, rich, and loose soils very congenial, and notable success has been obtained in the culture of these and kindred plants.

The swamps best adapted for the mints appear to be those which originally supported a growth of sphagnum moss and tamarack, the next in order of preference being the moister bur-oak lands. These soils must be thoroughly drained and the permanent water be lowered to at least 3 or 4 feet beneath the surface, as the mints make only a weak growth in sodden ground. The tillage of these broad stretches of level and easily worked soils affords much scope for the use of large horse tools and even for traction motors in hauling the mint hay, fuel, and supplies to and from the distilling plants. In the spring, the land is usually so soft from the contained moisture that the horses are provided with mud shoes, 9 or 10 inches wide, made of wood and leather and fastened to the hoofs or to the ordinary shoes by straps and metal bolts. Among the larger plantations these mud shoes are manufactured on the place.

On these muck lands planting begins in the spring as soon as the properly shod horses or oxen can be driven over the fields. The soil, cleaned by well-cultivated crops the year before, is plowed, leveled, and marked off in furrows 3 feet apart and 4 inches deep. The runners are dropped by hand, as in upland culture, but the soft footing renders the work more laborious, and it requires an expert laborer to plant an acre a day. The furrows are filled in with a drag wide enough to cover two or more rows of runners, and the weeder or light spike-tooth harrow is run over them to loosen the trampled surface. Harrowing is repeated at frequent intervals in various directions until the sprouts are too high to be further disturbed, after which corn cultivators are used between the rows until July, when the runners become so numerous as to render further tillage difficult.

Hand weeding is also used from the first appearance of the sprouts 10 days or more after planting, until the fields are thoroughly cleaned of weeds, grasses, and other plants that might lower the quality of the oil product. On large plantations it is usual to see gangs of 20 or more laborers, mostly recent immigrants, each gang under the direction of an experienced foreman, passing along the rows, hoe in hand, taking out all the interfering vegetation. Successful mint growing implies clean culture at all stages of progress.

The mint, when in bloom, is cut with mowers when the condition of the soil permits, but in rainy seasons machines do not always work well on new plantings and recourse must be had to the scythe. After sufficient drying in the swath, the mint is raked into windrows

the larger planters using continuous side-delivery hoes for the purpose. From the windrows it is usually hauled to the stills, but in dull weather it is at times necessary to complete the curing in cocks, although the rule is to handle the hay as little as possible, in order to avoid the loss of foliage.

The aftermath is plowed under after frost, as with upland culture, but on account of the loose nature of the soil it is covered somewhat deeper, frequently 4 to 5 inches. The second and third years of culture duplicate the first, except that cutting occurs nearly a month earlier. The harrow is started before the sprouts appear and is the main reliance as long as it can be used without materially injuring the new growth. Hand weeding begins early and is kept up until the mint has smothered out competing vegetation.

The life of a planting of mint in suitable muck soil averages about four years, after which it is found good practice to devote the area to a succession crop or to lay it down in pasture if grass can be induced to hold.

FERTILIZERS.

Notwithstanding the high nitrogen content of the swamp soils on which the mints are generally grown and their favorable texture for root penetration, there is often evidence of lack of quickly available plant food during rapid growth. Nitrate of soda, 50 to 150 pounds to the acre, well distributed and cultivated in before the tops have made too much growth, has been found profitable by progressive growers. Potash in the form of muriate or sulphate, from 150 to 300 pounds to the acre, has been widely used, with generally favorable results, to stimulate growth and darken the foliage. It appears particularly useful for a form of chlorosis apparently favored by too much water in the soil. Ground bone, acid phosphate, and lime have been tried in varying quantities by a few planters, but without marked benefit. The return of the steamed mint hay to the soil and the plowing under of the aftermath are most widely recognized as beneficial. Stable manure as a direct application is little favored, as it is often followed by watery growth and low oil content, while the resultant weeds are likely to become an intolerable nuisance. The indirect results of stable manure when applied to preceding well-cultivated crops are, however, of inestimable value.

DISEASES AND PESTS.

Aside from the chlorotic condition associated mostly with excessive moisture and probably also with too great acidity of the soil, peppermint has few serious diseases and spearmint has practically none. A rust fungus has been known to strip the foliage from the stems in particularly humid seasons, but it is usually quite local in its manifestations.

There is always the possibility of injury by crickets, grasshoppers and caterpillars if they appear in unusual numbers. Given congenial soil and the necessary cultural attention, however, the mints do not appear to rank in certainty of production much below the usual cultivated crops of temperate climates.

YIELD, COST, AND PRICES.

Yields of 2 to 3 tons of mint herb per acre may be expected. Where a market for the dried herb can be had, packers appear to prefer it chopped into 1-inch pieces and dried under cover, in order that the natural green color may be preserved as far as possible. The price received by growers for the properly cured mint herb of either species ranges from 3 to 5½ cents a pound, but the output of even a few acres would stock the market so that it would be difficult to dispose of any further quantities at paying prices.

The yield of oil is extremely variable in both peppermint and spearmint, ranging from almost nothing to nearly 100 pounds to the acre, according to the stand of the herb, its condition, and its treatment on cutting and distilling. The best yield of oil and the finest quality are to be expected the first year, after which there is a falling off each successive season until the mint is no longer worth cutting. It sometimes happens, however, that the second year proves to be the best. The largest yield is to be had only from fields which are in the best possible condition, but as a fair average for well-conducted commercial plantings, new and old, probably 30 pounds of oil per acre could be obtained, although many growers are inclined to place the average production somewhat higher. The condition of the weather at the time of cutting has an appreciable effect on the yield of oil, cool, dry weather appearing to produce less oil, even from the same field, than when the air is warm and fairly humid. About 320 pounds of peppermint and about 340 pounds of spearmint are required to produce a pound of oil in commercial practice, but as spearmint under similar cultural conditions furnishes more of the herb the yield of oil per acre is about the same.

Few commodities have fluctuated more widely in price than has peppermint oil. Wholesale or traders' prices, as quoted in publications devoted to the drug trade, have varied from 75 cents a pound in October, 1899, to \$5 a pound, in April, 1914. The average trade price for the oil in tins, as it comes from the producer, for the 40 years from 1877 to 1917, inclusive, is in the neighborhood of \$2.50 a pound, and on comparatively few occasions has it remained more than a month or two below \$1 a pound.

Spearmint oil was formerly quite limited in use, and the prices ran a little lower than those for peppermint oil, but of late the price has somewhat exceeded the latter, \$5 a pound having been reached in

1913, with a minimum of \$1.35 in 1915. The average trade price for the years from 1909 to 1917, inclusive, is about \$3 a pound. It must be borne in mind that the prices here given, for both peppermint and spearmint oils, are those quoted by jobbers and wholesale traders and doubtless exceed those generally received by producers. These oils, however, securely tinned, may be kept for years with little loss or deterioration and may conveniently be held out of market during periods of price depression.

Spearmint must be regarded as the less staple of the two mints, its consumption being largely restricted to the single industry of chewing-gum manufacture, and due caution should therefore be used in extending its culture.

As there is no great diversity in mint culture, the cost of preparation, tillage, and handling is perhaps more easily ascertainable than for many other crops. Careful inquiry in 1914 showed that the labor cost for establishing an acre of new mint on suitable soil in the Michigan-Indiana district and caring for it during the first season was about \$30. The cost in subsequent years could be placed at \$15 per acre. The estimates exclude fertilizers, taxes, interest on the land and equipment, superintendence, and other overhead charges. In Wayne County, N. Y., the cost of new plantings appeared to be less, as the land generally used needed less preparation, but the tillage costs were higher per acre, on account of the limited plantings and the greater amount of hand labor required. The price generally charged for runners sufficient to set an acre is \$5, and the customary charge for distilling is 25 cents a pound for the oil secured. As with all producing operations, the large equipments are supposed to reduce the unit cost of the product.

The early stills used in this country for the extraction of mint oils appear to have been metal retorts or covered kettles connected with a long, coiled tube, usually termed the "worm." During the process of distillation this coiled tube was immersed in cold water or showered, in order to condense the products of evaporation. The water and oil came out of the worm together and were received in a vessel called the separator, which had a siphonlike tube rising from near the bottom, by means of which the water could continuously flow away, while the oil, being lighter, rose to the top and could be drawn off through another opening. The separator of to-day remains practically the same, except that it has a greater capacity. Extensive changes, however, have been made in other portions of the distilling apparatus.

In the old kettle stills, the mints, often in the green or fresh state, were immersed in water, and direct heat was applied by means of a fire at the bottom of the kettle or boiler. The capacity of even the largest of these early stills was so limited that only a few pounds

of oil could be secured from a single charge. About the year 1840 large wooden vats, supplied with steam from an ordinary engine boiler, began to be substituted for the metal kettles. These vats were provided with a perforated false bottom upon which the herb rested, and distillation was effected by passing steam upward through the material. The vats were made of sufficient capacity to contain half a ton or more of the partially dry herb at a charge and were soon arranged in pairs, fed in alternation. The steam was conveyed through long pipes from a common boiler in such a manner that one vat could be emptied and refilled while the other was being steamed. The boiler also furnished the power for hoisting the charges and for the powerful steam pump which forced the cold water through the condenser or showered it over the pipes when they were exposed. The capacity for rapid work during the urgent harvest season was thus greatly increased, and with the spread of mint culture neighborhood community stills, each of which was capable of caring for the product of many growers, soon became common. In time the capacity of the vats was increased to hold a ton or more of the partially dry herb and a few distilling plants were built with four vats fed from a common boiler and arranged about a central crane by which the heavy exhausted charges could be lifted from the vats in alternation. The average cost of the 2-vat still, with boiler, pump, and sheltering structure, appeared to have exceeded \$500, and for a period of years these stills were said to have served about ten growers each.

In more recent years the large plantations of Michigan and Indiana, where the rows of mint plants under a single ownership sometimes exceed a mile in length, have necessitated far more extensive installations for expeditiously handling the vast quantities of the herb brought in from the fields. The most highly developed distilling plants to-day have four vats of approximately 3 tons capacity each arranged about a power crane. Steam is supplied by a battery of powerful boilers operating under a pressure of 110 pounds to the square inch, which effectually vaporizes the oil in the 3-ton charge in from 10 to 15 minutes. Water for cooling the immense condenser is obtained from deep-driven wells and is forced through by powerful centrifugal pumps. The separators used by these large stills are of sufficient capacity to contain several hundred pounds of oil. The old worms have generally been replaced by modern condensers composed of a considerable number of comparatively short, straight tubes leading to a common discharge outlet, the whole being surrounded by a capacious water jacket cooled by means of the connected pumps. The capacity of such a distillery, working continuously through the greater part of the 24 hours, is very large and is needed only for the most extensive

acres. The bulk of the mint grown in this country is distilled in equipments of the ordinary 2-ton capacity, many of which still serve the needs of several growers.

The proper drying of the herb after cutting is an important matter as regards economy of effort and the saving of time in distillation. More than three-fourths of the weight of the freshly cut tops is composed of water, the greater part of which is evaporated during exposure in the swath and windrow or in the cock when it is necessary to finish the curing in this manner. As commonly drawn from the field, the fresh weight of the herb is reduced considerably more than half, and the material not only packs better in the vats but requires only about one-third of the time needed for the distillation of the freshly cut herb, as it does not condense the steam to the same extent as fresh mint.

Laboratory experiments show an appreciable loss of oil in drying the herb, but growers are well convinced that the loss is not great enough to offset the increased cost of handling and distilling the green herb. Frost, however, occasions serious loss, as frozen mint yields scarcely half the quantity of oil which can be obtained from sound herb of the same character. Spearmint appears to lose slightly more oil by drying and freezing than peppermint.

TRADE IN PEPPERMINT OIL.

The quantity of peppermint oil produced in the United States exceeds the demand for domestic consumption. The surplus is exported, and in normal times England, Germany, and France in the order named take the larger part of the oil which is exported. Table I shows the foreign trade of the United States in peppermint oil.

TABLE I.—*United States imports and exports of peppermint oil, 1900–1916.*

[Compiled from Commerce and Navigation of the United States.]

Year.	Imports.		Exports.	
	Quantity.	Value.	Quantity.	Value.
	<i>Pounds.</i>		<i>Pounds.</i>	
1900.....	233	\$935	89,558	\$90,298
1901.....	1,200	1,353	60,166	63,672
1902.....	1,215	1,656	36,301	54,898
1903.....	11,128	13,881	13,033	34,943
1904.....	4,353	7,224	42,939	124,728
1905.....	16,185	18,733	36,953	135,060
1906.....	29,207	34,726	74,151	206,261
1907.....	13,643	18,839	147,722	499,082
1908.....	2,039	8,869	141,617	357,555
1909.....	1,239	6,416	161,811	288,318
1910.....	1,098	5,697	110,407	215,845
1911.....	2,127	12,126	123,420	269,034
1912.....	1,839	11,411	155,740	422,631
1913.....	3,529	13,097	134,663	395,551
1914.....	18,794	41,367	117,809	397,050
1915.....	9,200	8,959	184,981	384,593
1916.....	17,066	12,573	154,096	323,070

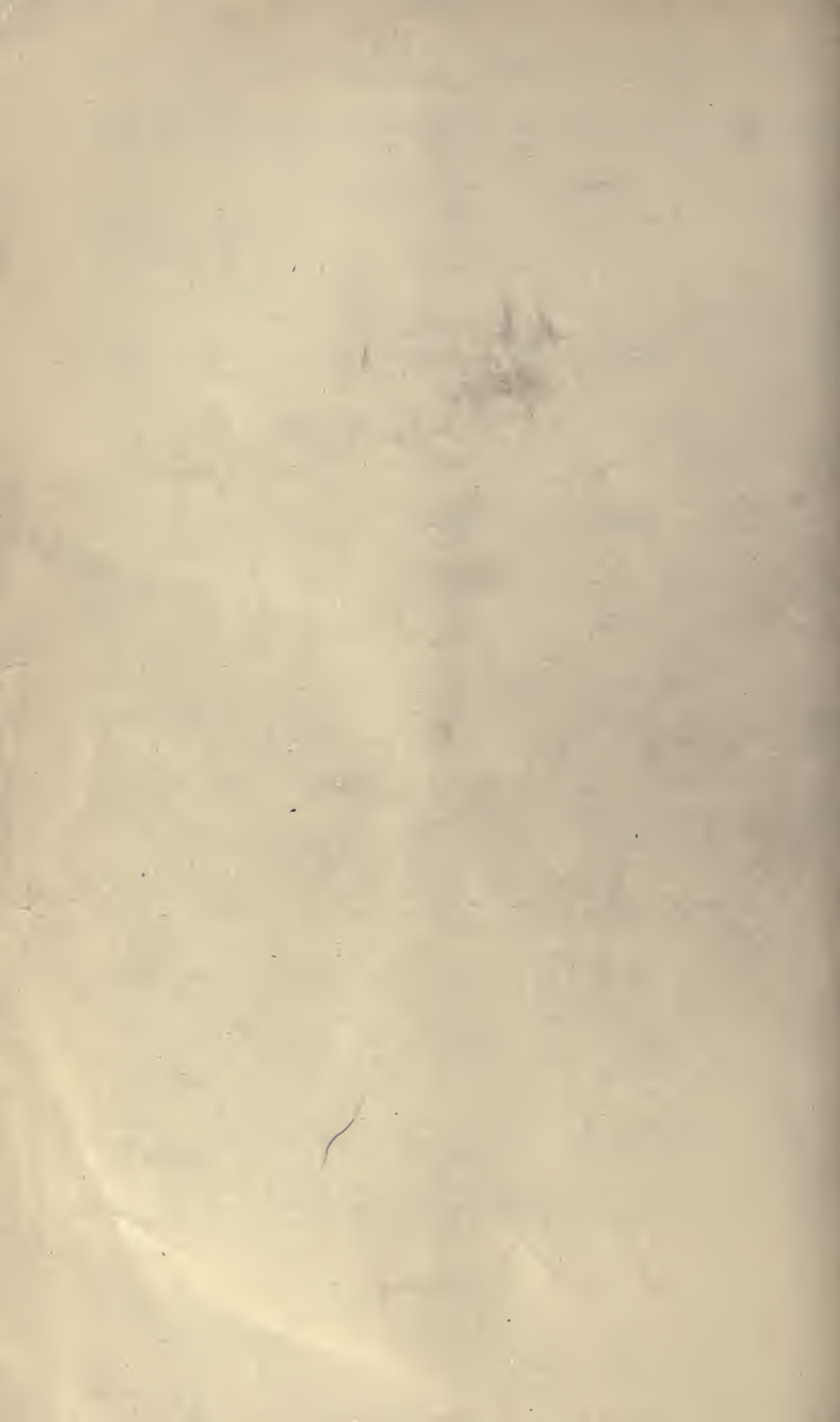
PUBLICATIONS OF THE UNITED STATES DEPARTMENT OF AGRICULTURE RELATING TO DRUG PLANTS, ETC.

AVAILABLE FOR FREE DISTRIBUTION.

- Weeds Used in Medicine. By Alice Henkel. Pp. 45, figs. 31. 1904. (Farmers' Bulletin 188.)
- Growing and Curing Hops. By W. W. Stockberger. Pp. 39, figs. 20. 1907. (Farmers' Bulletin 304.)
- Harmfulness of Headache Mixtures. By L. F. Kebler, F. P. Morgan, and Philip Rupp. Pp. 16. 1909. (Farmers' Bulletin 377.)
- Habit-Forming Agents: Their Indiscriminate Sale and Use a Menace to the Public Welfare. By L. F. Kebler. Pp. 19, figs. 5. 1910. (Farmers' Bulletin 393.)
- The Cultivation of American Ginseng. By Walter Van Fleet. Pp. 14, figs. 3. 1913. (Farmers' Bulletin 551.)
- Goldenseal under Cultivation. By Walter Van Fleet. Pp. 15, figs. 5. 1914. (Farmers' Bulletin 613.)
- The Source of the Drug Dioscorea, with a Consideration of the Dioscorea Found in the United States. By Harley Harris Bartlett. Pp. 29, figs. 8. 1910. (Bulletin 189, Bureau of Plant Industry.)
- Some Effects of Refrigeration on Sulphured and Unsulphured Hops. By W. W. Stockberger and Frank Rabak. Pp. 21. 1912. (Bulletin 271, Bureau of Plant Industry.)
- Drug Plants under Cultivation. By W. W. Stockberger. Pp. 39, figs. 8. 1915. (Farmers' Bulletin 663.)

FOR SALE BY THE SUPERINTENDENT OF DOCUMENTS.

- The Adulteration of Drugs. By Lyman F. Kebler. Pp. 251-258. 1904. (Separate 331, from Yearbook of the Department of Agriculture, 1903.) Price, 5 cents.
- Peppermint. By Alice Henkel. Part 3, pp. 19-29, figs. 3. 1905. (From Bulletin 90, Bureau of Plant Industry.) Price, 5 cents.
- Wild Medicinal Plants of the United States. By Alice Henkel. Pp. 76. 1906. (Bulletin 89, Bureau of Plant Industry.) Price, 5 cents.
- American Root Drugs. By Alice Henkel. Pp. 80, figs. 25, pls. 7. 1907. (Bulletin 107, Bureau of Plant Industry.) Price, 15 cents.
- The Sources of Arsenic in Certain Samples of Dried Hops. By W. W. Stockberger. Part 4, pp. 41-46. 1908. (From Bulletin 121, Bureau of Plant Industry.) Price, 5 cents.
- American Medicinal Barks. By Alice Henkel. Pp. 59, figs. 45. 1909. (Bulletin 139, Bureau of Plant Industry.) Price, 15 cents.
- American Medicinal Leaves and Herbs. By Alice Henkel. Pp. 56, figs. 36. 1911. (Bulletin 219, Bureau of Plant Industry.) Price, 15 cents.
- The Diseases of Ginseng and Their Control. By H. H. Whetzel and J. Rosenbaum. Pp. 44, figs. 5, pls. 12. 1912. (Bulletin 250, Bureau of Plant Industry.) Price, 15 cents.
- American Medicinal Flowers, Fruits, and Seeds. By Alice Henkel. Pp. 16, figs. 12. 1913. (Bulletin 26, U. S. Department of Agriculture.) Price, 5 cents.
- Wild Volatile-Oil Plants and Their Economic Importance. I.—Black Sage II.—Wild Sage; III.—Swamp Bay. By Frank Rabak. Pp. 37, figs. 6. 1912. (Bulletin 235, Bureau of Plant Industry.) Price, 5 cents.



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Contribution from the Bureau of Entomology, L. O. Howard, Chief.

OUTDOOR WINTERING OF BEES.

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and

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INTRODUCTION.

The beekeepers of the United States lose at least one-tenth of their colonies of bees every winter. This is a minimum loss, which is frequently increased to one-half and sometimes more in certain sections. This decrease is largely due to carelessness or to lack of knowledge, and it is entirely practical to reduce it to less than 1 per cent, the small loss covering various accidents which can not be foreseen. An industry which can survive in the face of such a decrease must have great possibilities for commercial advancement when the loss is properly reduced.

An important reason for the unnecessary death of colonies in winter is the belief of many beekeepers that, since unprotected colonies often live over winter, no protection is needed. When, for example, heavy insulation of bees is advocated at a beekeepers' convention, some beekeeper usually replies that he has never protected his colonies and never loses any. His reported success is often unintentionally exaggerated, and he indicates by such statements that he may not know what constitutes moderately successful wintering. Although probably nothing on a farm gives a better return on the investment than do bees if well cared for, the majority of beekeepers neglect them. It need scarcely be stated that the best beekeepers do not follow such a parsimonious and unwise policy.

It is usually believed that winter loss is confined to the northern portions of the country, but this is far from true. The beekeepers of the South lose many colonies during this season, and, peculiarly

NOTE.—This bulletin deals with the care of bees in winter when wintered outside and is of interest to beekeepers in all parts of the United States.

enough, the decrease in all parts of the United States is due to the same causes in varying degree.

For the past three winters the authors¹ have made a study of the activity of bees during the winter and of the effects of various environmental factors on the colony. This bulletin does not include the results of this work, but gives the methods of outside wintering which have proved best in commercial apiaries, all the statements here made having been substantiated by the results of the more detailed studies which are to be reported in other form. There are many factors which require still more study and the doubtful points are not here discussed. It seems best not to include a discussion of the wintering of bees in cellars, concerning which there are many more points in dispute which can be settled only by detailed scientific studies. This omission should not be interpreted as indicating that the authors condemn cellar wintering; in fact, they are inclined to believe that when properly worked out this method will be found superior in northern localities.

Beekeepers usually report the results of wintering by giving the percentage of colonies in which all the bees die, just as was done in the first paragraph of this bulletin. This is a convenient method but is misleading. If every individual bee that goes into winter quarters remained alive in the spring with no loss of vitality, we should have perfect wintering, but such success is impossible. If out of 100 colonies only 2 die and the remainder are only half as strong in numbers as they were in the fall, most beekeepers would consider this rather good wintering, while in fact it is poor. The criterion of success is to save the greatest possible number of individual bees and to have them capable of prolonged activity in the spring. Beekeepers sorely need a new point of view as to success with this vital problem.

Frequently in beekeeping literature mention is made of the "winter sleep" of bees. Bees can not hibernate as do most insects. While the bees on the outside of the winter cluster are usually quiet, there is incessant movement in the center during cold weather; in fact, the colder the surrounding air, the greater the activity of the colony after a cluster is formed. The phrase "winter sleep" is therefore erroneous and should be dropped from the literature, as it misleads beekeepers.

CAUSES OF WINTER LOSS.

The causes of the death of individual bees or of a colony of bees in winter, barring unusual accidents, are only two in number: (1)

¹ For a preliminary report of this work see Phillips and Demuth, 1914. The temperature of the honeybee cluster in winter, Bul. 93, U. S. Dept. Agr., 16 p.

Inadequate stores and (2) excessive heat production. The numerous factors usually given in the literature on the subject as entirely distinct fall into these two classes, except for some that are usually given which the authors do not believe to be operative.

EXCESSIVE HEAT-GENERATION.

It was first shown by the authors in the bulletin to which reference has been made that at hive temperatures between about 57° and 69° F. a normal broodless colony of bees does not form a cluster, but the bees remain inactive on the combs. When the temperature of the air immediately surrounding the bees (not the temperature of the air outside the hive) falls to 57° F. or lower, they form a cluster and those in the center begin to generate heat by muscular activity, while those in the outer portion serve as insulators by crowding close together, usually with their heads toward the center of the cluster. The innermost portion rapidly acquires a temperature considerably higher than that of the air about the bees before clustering was necessary, often going to 90° F. in normal colonies and higher in abnormal ones. The number of bees engaged in heat production increases as the outer temperature falls and the insulating zone is consequently decreased in thickness but becomes more compact. The entire cluster becomes smaller as the outer temperature falls.

If bees can be kept in an environment such that the temperature of the air immediately surrounding them is 57° F. or slightly above, they are saved much unnecessary and unprofitable labor. To the theoretical objection that bees need exercise, it is necessary only to state that the authors have so wintered bees in a cellar as well as outdoors with wonderfully successful results. If bees are kept in a cellar under the best conditions the results are excellent, but it is not proposed to discuss this more complicated phase of the subject here. If wintered outside in a packing case with abundant insulation, any heat generated escapes slowly and the temperature of the air in the hive rarely falls below 55° F. If inadequately protected, the temperature of the hive can not be kept so high and the bees must generate much more heat. In single-walled hives it is common for the temperature of the air around the cluster to fall to freezing or lower, in which event the bees generate an excessive amount of heat and perhaps die when they are no longer capable of the necessary muscular activity. The necessity of packing is thus made clear, and in any locality in which the outer temperature often falls to 40° F. or below it is desirable to protect bees to conserve their vitality. If the temperature should fall to 40° F. only a few times during the winter, this would not be serious enough to make insula-

tion necessary. It is obvious, however, that winter protection is beneficial throughout practically the entire United States.

Necessity of having young bees.—Bees may be compared with minute dry batteries, in so far as their vital energy is concerned. They emerge as adult bees with a certain amount of vital energy, and when this is exhausted they die, not having power to recover lost vitality as human beings have. To withstand the hardships of winter under usual conditions, a colony must have many young bees capable of prolonged muscular work. Obviously the better the wintering conditions, the less necessary it becomes to provide young bees, but even with the most perfect wintering it is desirable that there be plenty of young bees in the fall, so that they will be available for extensive brood-rearing in the spring. This calls for prolonged brood-rearing in late summer. Old bees, which have been worn out earlier and are ready to die, soon succumb from the work of heat-generation.

Danger of weak colonies.—In a strong colony many bees in the center of the cluster may be engaged in heat-generation, and there will still remain many bees to serve as insulators. A weak colony, on the other hand, has less reserves for insulation, and, since heat is rapidly lost, the bees on the inside must generate excessive heat in order that the outermost bees may always be at a temperature of over 50° F. Since the surface of a spherical cluster is proportionate to the square of the diameter, while the volume is proportionate to the cube of the diameter, it follows that a large colony cluster has a relatively smaller surface for radiation of heat than does a small one. Below about 50° F. individual bees become numb, and so long as the cluster remains active the authors have never found normal bees at a temperature lower than the critical temperature, 57° F. In a small colony the inner temperature is often many degrees warmer than that of a neighboring strong colony, which doubtless explains the prolonged brood-rearing of weak colonies in the fall. Most colonies which die of excessive heat-generation are rushed to their doom by the temperature being high enough to start brood-rearing which is perhaps one of the most unfortunate circumstances which a colony can experience in winter. By all means a colony should be so protected that brood-rearing will not be begun until frequent flights are possible.

Since weak colonies so frequently succumb in winter, it is obvious that a too rapid increase in the number of colonies in summer is unwise. Beekeepers have learned that swarming is to be avoided because of the resulting reduction in the honey crop, and the loss in winter is an additional argument against allowing the bees to exercise this instinct freely. It is a common saying among beekeepers that a rapid increase is usually followed by a rapid decrease. It is impossible to

get too strong a colony for winter, the error always being in the opposite direction.

Effects of accumulation of feces.—It was first shown by the authors that heat-generation causes increased consumption of stores; this in turn causes an accumulation of feces within the bees, which is more rapid if the stores contain a high percentage of indigestible materials, and the presence of feces causes increased activity, often resulting in death from excessive heat-generation. Beekeepers call this condition dysentery if the accumulation is so excessive that the bees are unable to retain the feces. Dysentery causes the death of bees in winter, so far as has been seen, solely by undue activity and excessive heat-production. This detrimental effect is reduced by good stores, but obviously the proper method is to prevent an unnecessary accumulation of feces by preventing a heavy consumption of stores, chiefly by providing a sufficiently high surrounding temperature. Honey-dew honey is especially injurious because of the rapidity with which feces accumulate.

In mild climates, in which there are frequent days when bees can fly and rid themselves of feces, the injurious effects of poor stores are less noticeable, because the feces do not accumulate sufficiently to cause abnormal activity. The accumulation of feces is to be considered as an irritant, causing responses similar to disturbance by jarring or exposure to light.

Influence of the queen.—In discussions of wintering it is usually stated that to winter well a colony must have a good queen. Obviously a good queen will better prepare a colony for winter by providing a strong colony of young bees than will a poor one, while a colony that is queenless in late summer and fall has little chance of living until spring. A good queen will also increase brood-rearing rapidly in the spring, if the colony has good stores and has been properly protected during the winter. Aside from the important influence on the population of the colony, the queen probably plays no part in wintering.

Spring-dwindling.—If the individual bees of a colony are reduced in vitality by excessive heat-production, they may live until spring, but are unable to do the heavy work then needed to bring the colony back to full strength. The adult bees die more rapidly than they are replaced by emerging bees, and the population decreases. This condition, which can be produced experimentally, has long been known among beekeepers as "spring-dwindling." If this condition is observed, the bees may perhaps be slightly relieved of further unnecessary work by packing to conserve heat and by giving abundant stores, but the proper treatment is to prevent the condition by proper care in the preceding fall and winter. The term "spring-dwindling" should not be applied to death of bees from other causes.

LACK OF STORES.

A common cause of the death of colonies in winter is starvation which is more certainly due to carelessness on the part of the bee-keeper than is unnecessary heat-production. The greater the necessity for heat-production, the more necessary it becomes for every colony to have an abundance of stores of good quality. The amount required varies with the length of the winter, and also with the amount of heat which is generated. It is, of course, necessary also to provide or leave stores enough for brood-rearing in late winter or spring, before sufficient stores come to the hive from natural sources.

COMPARISON OF THE COLONY WITH A FURNACE.

Let us assume that we have a furnace for heating a building so constructed that ashes may be removed only when the temperature of the outer air is warm. If the house has thin walls and many openings, the furnace can not maintain a high temperature in extreme cold weather, the amount of fuel consumed is increased, the ashes accumulate rapidly and clog the furnace, and in a desperate effort to raise the house temperature we should probably burn out the furnace. On the other hand, if the house is well built and heavily insulated, a low fire will suffice, and as a result there will be a minimum amount of ashes. The better the fuel, the less the amount of ashes in either case.

It is permissible to compare a colony of bees as a unit of heat-production with this furnace. If the bees are in a single-walled hive in a cold climate, the colony must generate a great amount of heat, must consume much more honey, and feces will accumulate rapidly. As the bees are unable to discharge their feces until the temperature of the outer air is high enough for flight, the "furnace" is clogged. The bees are "burned out" by the excessive heat-production, and, even worse than in the case of the furnace, the irritation resulting from the presence of feces causes still more heat-production. On the other hand, if abundantly insulated, the heat generated is conserved, the consumption of stores and amount of feces are reduced, and the bees can readily retain the feces until a flight day, in any place in which bees can be kept. The better the stores the less the amount of feces in either case.

We should not expect much of a furnace in an open shed, and we have no more right to expect good results from a colony wintered in a thin-walled hive in a cold climate, or even in a better hive placed in a windy location.

CONSERVATION OF HEAT AND REDUCTION OF EXPENDITURE OF ENERGY.

In outside wintering the heat produced by the bees is conserved by the insulation of the cluster itself and also by the insulation of the hive and packing. In the cellar there is less insulation near the cluster, but the cellar itself replaces the packing, and is in reality simply an insulation. The insulation of the individual hive, of several hives packed together, or of bees in a cellar serves solely to reduce the loss of heat generated by the bees.

The amount of packing that should be used obviously varies with the climate and it is impossible to make definite general statements in a bulletin intended for all parts of the United States. There is one general statement which can be made with safety: The majority of beekeepers do not give sufficient insulation and no beekeeper ever gave a colony too much. For example, in the relatively mild climate of Washington, most beekeepers winter their bees in single-walled hives. The authors have used a large packing case holding four hives, two facing east and two west, close together. This case was constructed so as to hold 3 inches of packing below, 5 inches on the ends, 6 inches on the sides, and 8 to 12 inches on top. Colonies wintered in such a case in Philadelphia in 1913-14, and in the apiary of the Bureau of Entomology at Drummond, Md., near Washington, in 1914-15, were in much better condition than colonies left unprotected, and cases of this general type are being constructed for the entire apiary at Drummond, except for such colonies as are used in other wintering experiments. The dimensions here stated should by no means be accepted as best for other localities, especially those farther north, where the protection should be heavier, but in this particular packing case the temperature of the air within the hive but outside the cluster usually stood at about 55° to 57° F., except for a reduction in temperature under one condition to be discussed on the next page. The aim of the beekeeper should be to keep the air about the bees at about 57° F., at which temperature there is no condensation of moisture within the hive, even on the inside of the cover, where it first appears. It might be inferred that if double the amount of packing had been used the temperature of the air about the bees would have been too high. This is not the case, for bees cease heat-generation when the temperature reaches 57° F., (or even sooner when the surrounding temperature is rising¹), and the temperature will not exceed 57° F. unless that of the outer air remains higher than that for a considerable period.

Bees well protected and with good stores do not fly from the hive because of the warmth within when the outer air is too cold for them

¹ See Department Bulletin No. 93.

to do so safely. If bees fly at low temperatures (45° to 50° F.), it is an indication that they need a flight because of an accumulation of feces from poor wintering, and does not at all indicate too high an inside temperature because of too much packing. In conclusion the beekeeper can not apply too much insulating material to a hive.

It has been found that, even with abundant insulation, the temperature within the hive and outside the cluster is greatly reduced if the packing case is exposed to wind. During the winter 1914-15 a record was kept of wind velocity directly over a heavily packed case (with entrances $\frac{3}{8}$ inch by 8 inches), and it was found that a wind with a velocity of 20 miles per hour directly on the case reduces the temperature within the hives practically to that observed in an unprotected hive. The beneficial effects of the insulation were therefore nullified, and the proper temperature within the hive was not regained for several days unless the outer temperature rose considerably. Beekeepers have long emphasized the importance of protection from wind, but the results observed were much more pronounced than was anticipated or than has ever been suspected by practical beekeepers. The ideal toward which the beekeeper should work is to keep his colonies during cold weather absolutely protected from wind, for here again the protection can not be too great. It is entirely erroneous to assume, as some have done, that such protection is not essential in well-packed hives.

There are several types of hives on the market in which the insulation is built in, to be retained throughout the year. There is no objection to the packing in the summer, except that such hives are not convenient for moving and in some other manipulations. Insulation in commercial double-walled hives is by means of air spaces or insulation, such as sawdust, chaff, broken cork, or shavings. These hives are better for outside wintering than single-walled hives in any part of the United States, but they do not provide adequate insulation at temperatures below about 40° F. Such hives must, of course be protected from wind, or they are for the time being no better than single-walled hives.

Types of insulation.—Various materials are used for insulation. Beside those named above, paper, dry leaves, and many other substances are in use. Most of the common insulating materials depend on small confined dead-air spaces for their insulating value, and in general, the more finely divided the air spaces the more efficient the material. Sawdust is usually condemned, because if moisture escapes from the hive into the packing it is retained and the insulating value is reduced. However, if a colony is sufficiently packed, moisture does not condense, except possibly at extremely low external temperatures, and this objection to sawdust is removed. From observa-

sions so far made, it appears that the beekeeper may use the materials most easily obtained. If dry leaves are used, they should be packed tight, but sawdust should simply be poured in place without being packed tight.

The entrance.—The weak place in hive insulation is the entrance. An opening 8 inches wide and $\frac{3}{8}$ inch high is abundant, it usually being constructed as a tunnel through the packing. In cold weather this might be still further reduced. The opening should be shielded from the wind, to prevent a rapid loss of heat, for if the wind blows against the entrance the heat stored up in the packing is lost both to the outside and the inside. The only reason for an entrance as large as the size mentioned above is the danger that dead bees will drop from the combs and block a smaller entrance. Since the number of dead bees is greatly reduced in well-insulated hives this is less important, and, furthermore, if the air within the hive is warmed to 57° F. the dead bees will be pushed outside, even in freezing weather.

Methods of packing.—The exact method of packing is not especially important, provided enough insulation is given on all sides. Colonies may be packed singly in any sort of box, or they may be packed in groups of four, as previously described (p. 7). Some beekeepers arrange colonies in long rows and apply insulation to the whole row. The placing of several hives in contact has the advantage that the colonies insulate one another. If arranged in groups of four, two facing east and two west, they may be left on the same stand throughout the year and are readily manipulated during summer. If in long rows close together, summer manipulations are impeded, unless the hives are moved after the insulation is removed. Placing colonies in long rows is therefore not advisable. Whatever type of outer case is used, it should be tight, to prevent rain and snow from wetting the insulating material.

A rather common practice is to pack the hive at the sides, top, and rear, but to leave the front unprotected and faced to the south, the object being to utilize the heat of the sun to warm up the interior of the hive and reduce the work of the bees. Any place through which external heat may readily reach the interior of the hive is also efficient as an avenue through which heat may be lost when the sun is not shining. Since the sun shines less than half the time in winter, making no allowance for cloudy days, the weakness of the argument for this practice is obvious. A similar practice is to paint the packing cases a dark color to absorb the sun's heat. Considerably more detailed work is needed to determine to what extent this source of heat is of value to the colony.

Time for packing.—At the time of the first killing frost the beekeeper should promptly remove supers, if any are on his hives. If

the bees are not adequately supplied with good stores for winter they should now be given immediately, and, when the feeding is finished the winter insulation should be applied at once. At this time bees are the quietest of any period of the year. The disturbance incident to putting on the insulation does not do them any harm. After this the beekeeper should have no occasion to open the hive until spring. An outer temperature above 60° F. is desirable at the time of packing, especially if no brood is present. Any day when bees are flying is suitable.

If packing is delayed until late it may do far more damage than to leave the bees unpacked. A colony of bees that is generating heat in response to low temperature is considerably disturbed by the manipulations during packing and the temperature of the inside of the cluster is promptly raised. Frequently, if bees are packed too late (when it is too cold outside), the cluster temperature is raised to brood-rearing temperature, the queen begins to lay eggs, and brood-rearing is usually then continued through the winter, unless it results in the death of the colony, as is often the case. Many beekeepers pack their colonies in December with most harmful results. There is probably no place in the United States where packing is needed in which it is safe to wait later than Thanksgiving Day. Since more beekeepers make mistakes here than in any other phase of outside wintering, this should be emphasized most strongly. The authors have succeeded on several occasions in starting brood-rearing in December by manipulation, both in colonies wintered outside and in removing bees to a cellar, and it is certain that such winter brood-rearing is highly injurious to the colony.

Time for unpacking.—If a colony has a good queen and plenty of stores and is well packed, the beekeeper rarely has any reason for opening the hive until spring is well advanced. If he is not sure of the condition of the colony, he may wish to examine it earlier, but this first examination should be brief and the packing may be partially removed and replaced afterwards. If there are any queenless colonies or any colonies short of stores, these defects should, of course, be promptly corrected, after which the colony should remain undisturbed until, as the season advances, frequent manipulations are necessary. It is often best to leave the insulation on until the colonies need more room, which will probably be as late as May 15 in the North. Colonies which have wintered poorly need their insulation longest, while colonies that have been well insulated, either in a cellar or outside, can, if necessary, stand considerable exposure without much damage, although the work of heat-generation thereby reduces the energy available for building up the colony rapidly.

The time for removing packing may be still further delayed by wintering a colony outside in two-hive bodies, the upper one being

well supplied with honey. Since there is more space to keep warm, such a hive should be more thoroughly insulated. If this plan is followed, the beekeeper is sure that sufficient stores are available and he can probably locate any queenless colonies by a brief external examination. Since wintering in two-hive bodies has not been practiced extensively, it should be tried with caution, but reports of this method should be available from all parts of the country and beekeepers are urged to try it on an experimental scale. The plan has much to commend it.

Providing a windbreak.—It is well established that a windbreak of evergreens is superior to a solid windbreak such as a house or solid fence. The beekeeper can readily determine whether his bees are located in a place where the wind rarely or never blows more than 5 miles an hour in winter. If the apiary is not so located, it should be moved during the summer to a place in the woods, in a gulch, or in some other sheltered place. Bees should never be moved in winter. If it is not practicable to move the apiary, a high fence, perhaps 8 feet high, should be constructed on the exposed sides. The more compact the apiary, the easier it is to construct a windbreak, which is an argument for placing colonies in groups of four. Evergreens are slow growing, and a high fence may be used until the permanent windbreak is sufficient. If the apiary is practically surrounded by buildings, this may be adequate protection, but such a location is usually not the most convenient for the apiary. A southern exposure is usually recommended as best for winter, for it is claimed that the heat of the sun is beneficial. Since the sun shines only a small fraction of the time in winter in most localities, especially in the East, where there is much cloudy weather, this feature should not be unduly emphasized.

PROVIDING ADEQUATE WINTER STORES.

The amount of honey that a colony will need from the time it is packed until it is unpacked can not be closely estimated. The aim of the beekeeper in winter should be to save bees rather than honey, and he can make no more profitable investment than to give his bees more than they can possibly use. Some beekeepers claim that it is best to have the old bees die soon, so as to save stores. The actual consumption in such badly wintered apiaries is probably not at all decreased.

If the bees do not have sufficient stores, they may be given combs of honey, but these should always be given before cold weather, so that a proper clustering space may be formed by the moving of honey, since bees always cluster in empty cells of the comb adjacent to stores.

If honey in combs is not available, the bees may be fed extracted honey, but the usual practice is to feed a thick sugar sirup made of 2 or $2\frac{1}{2}$ parts of sugar to 1 part of water by volume. To this sirup 1 ounce of tartaric acid should be added for each 40 to 60 pounds of sugar while the sirup is being heated to the boiling point to dissolve the sugar crystals. The sirup should be boiled 15 minutes. The acid helps to invert the cane sugar, thus retarding its granulation in the combs. If there is any question as to the quality of the stores, it is a good practice to feed about 10 pounds of sirup at the time of packing, in addition to the stores provided earlier, this being stored immediately above the cluster. It is thus used first, and an accumulation of feces does not occur so long as the bees use only the sugar sirup. There is, however, no better food in winter than a good quality of honey. As was stated earlier, honey-dew honey causes a rapid accumulation of feces, resulting in dysentery. If this is present in the fall, it should be removed and better stores given. Some fall honeys are similarly injurious, but their injurious effects may be reduced by feeding sirup at the time of packing.

SUMMARY AND CONCLUSIONS.

Bees need protection from cold and wind in winter in practically all parts of the United States. The beekeeper should give abundant insulation, since it is impossible to give too much and since most beekeepers give too little. Great care should be exercised to protect colonies from wind. Every colony should be strong in the fall, so that heat may be generated and conserved economically. To reach the proper population a good queen is necessary.

Many colonies die of starvation in winter. This can easily be avoided.

The beekeeper can make no better investment than to give his colonies proper care for winter.

If the excessive winter losses are prevented, commercial beekeeping will be greatly benefited. Such a condition is entirely possible when beekeepers come to understand the fundamental principle of wintering.

UNITED STATES DEPARTMENT OF AGRICULTURE



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Contribution from the Bureau of Plant Industry, Wm. A. Taylor, Chief.

HANDLING AND SHIPPING CITRUS FRUITS IN THE GULF STATES.

by H. J. RAMSEY, *Pomologist in Charge of Fruit Handling and Storage Investigations.*

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INTRODUCTION.

The object of commercial fruit growing is profit. Even though a grower is successful in securing satisfactory yields of high-quality fruit, it does not necessarily mean that the business of fruit growing is a success financially. The primary object of commercial fruit growing can not be attained unless the crop can be disposed of profitably. Too many fail to realize that under modern conditions of handling, of long-distance shipment, and of marketing a perishable commodity such as citrus fruits, the growing of fruit is one thing and the marketing of it necessarily entirely another. Few growers possess the wide perspective or experience or can individually afford to obtain the information necessary to market their fruit to best advantage. The distribution and selling can be more successfully handled by thoroughly trained men and organizations devoting their entire time and effort to the disposal of such crops.

No attempt will here be made to discuss systems of marketing, or the marketing question in the usually accepted sense, but rather to point out some of the factors governing the merchantable condition

of fruit, particularly the relationship of harvesting and handling methods to losses from decay in transportation and at the markets.

Soundness and good keeping quality are of fundamental importance in the successful disposal of a perishable fruit crop. No system of marketing can procure for the grower the highest market price for his product unless it is delivered in sound condition, so that it will remain in good merchantable condition for a sufficient time to allow for proper distribution to the consumers. If the grower can not deliver his fruit at the market in good, sound, attractive condition, the money and labor invested in his orchard enterprise are largely, if not wholly, wasted.

CAUSES OF DECAY IN TRANSIT.

The losses from the decay of citrus fruits in transit and on the market are due primarily to fungi, which attack and cause decay or rotting of the fruit. Broadly and generally speaking, these fungi may be divided into two classes, parasitic and saprophytic. Parasitic fungi have the power to attack and cause decay in sound, uninjured fruit, saprophytic fungi usually can gain entrance and cause decay only through injuries, mechanical abrasions, or breaks in the skin or the cells composing it. It is safe to say that more than 95 per cent of the decay of citrus fruits occurring on arrival at the market and during the first ten days after arrival are due to attacks of fungi gaining entrance only through injuries of some kind. Blue mold is practically the only fungus of this type causing decay in oranges, grapefruit, lemons, and other citrus fruits in transportation and on the market. The losses from blue-mold decay, however, are oftentimes very serious and frequently the sole reason for low prices, demoralized markets, and losses instead of profits to the grower. There is not only the direct loss of fruit through decay, but the indirect losses due (1) to depreciation in prices for fruit actually sound, (2) to a reputation for poor keeping quality, and (3) to the proportionally high overhead expense of handling a perishable product which develops great waste and spoilage in transit and after arrival at the market.

The decay of citrus fruits from the Gulf States caused by parasitic fungi is usually not very serious, especially in transit and for the first week after arrival at the market. The most serious losses from this cause are due to attacks of fungi causing the type of decay commonly known as stem-end rot. Usually no stem-end decay is found on the arrival of the fruit in the market, nor does much of it develop under ordinary conditions during the first week after arrival. The losses from this decay are the most severe following a holding period of ten days or two weeks. This disease varies in severity with seasons and also with periods during any one shipping season. Climatic and tem-

perature conditions are very important factors governing the development of this disease both in the orchard and after the removal of the fruit from the tree, the losses being usually much heavier in the orchard than in transportation. If affected fruit could be successfully culled out at the time of picking and packing, stem-end rot would be a negligible factor in the marketing of the citrus crop, at least as far as the fruit actually shipped is concerned. The impossibility of grading out the affected fruit except such specimens as actually show decay from this cause makes it frequently an important factor in determining the keeping quality of the fruit on the market.

Diplodia rot is oftentimes associated with stem-end decay and during some seasons may be very serious. It closely resembles stem-end decay due to *Phomopsis*, and in the earlier stages is indistinguishable from it. For this reason it is also commonly referred to as stem-end rot. In Porto Rico and Cuba this *Diplodia* rot, next to blue mold, is one of the most serious causes of the decay of citrus fruits in transit and on the market.

Colletotrichum, or anthracnose, sometimes causes some decay in both oranges and grapefruit on the market, especially if these fruits are held for a long time under ordinary warehouse conditions or in cold-storage temperatures. In the handling of citrus fruits through the usual channels this disease is ordinarily not of importance.¹

PREVENTION OF LOSSES DUE TO DECAY.

Obviously, the prevention of losses due to stem-end decay and diseases of a similar nature must depend on proper orchard, cultural, and sanitation practices, at least in so far as such practices can be depended upon to control or lessen the severity of attacks in the orchard. As stem-end rot develops very slowly in temperatures below 45° to 50°, the liability to serious losses can be minimized by prompt cooling, the transporting of the fruit under low temperatures, and the holding of it on the market so far as practicable under low temperatures.

By far the most serious losses, as already pointed out, are due to blue mold, a fungus that gains entrance to and causes decay of citrus fruits only through injuries and breaks in the skin. Extensive investigations² and practical commercial experience have conclusively demonstrated that citrus fruits can be handled with sufficient care to prevent these injuries and to deliver the fruit on the market in good condition, even under adverse climatic surroundings (fig. 1).

Discussion and description of the diseases mentioned as sometimes being the cause of decay of citrus fruits in transit and after arrival at the market may be found in the following publications of the Florida Agricultural Experiment Station: Bulletin 53, "Some Citrus Troubles," by H. H. Hume; Bulletin 107, "Stem-End Rot of Citrus Fruits," by H. S. Fawcett; Bulletin 108, "Diseases of Citrus Fruits," by P. H. Hs and others; Bulletin 111, "Melanose and Stem-End Rot," by Floyd and Stevens.

For a report upon these investigations, see U. S. Department of Agriculture Bulletin No. 63, entitled "Factors Governing the Successful Shipment of Oranges from Florida," 1914.

It has been conclusively shown that in so far as good, sound, merchantable condition is concerned the responsibility rests primarily with the grower and the shipper. The care exercised in preparing the fruit for market determines to the greatest degree its condition on arrival and its keeping quality while being held for distribution to the consumer. Keeping clearly in mind the importance of sound fruit on the market and the responsibility of growers and shippers for the condition of fruit on arrival and while being held on the market, one can not but be impressed with the fact that the grower himself largely determines the relative market price of his fruit. The matter



FIG. 1.—Oranges used in the Florida shipping experiments in 1911, showing the condition of the fruit on arrival at the market. This shipment was made during a period of very unfavorable climatic conditions. Blue-mold decay developed as follows (from left to right): Careful pick and pack, 4 per cent; commercial pick and careful pack, 35.6 per cent; commercial pick and pack, 68.1 per cent.

of proper handling is an economic problem of greatest importance, a problem of thorough organization and of human efficiency. The success or failure of the orchard enterprise often depends on this factor alone. Certainly no grower can hope to obtain the fullest measure of success without the strictest attention to methods of handling and harvesting in preparing his fruit for market.

WHAT CAREFUL HANDLING MEANS.

Many growers realize, at least to some extent, the importance of and necessity for careful handling, but oftentimes have no clear idea of what careful handling means or the seriousness of the slightest injury to the fruit. The elimination of losses due to blue-mold decay

is not a matter of attention to one or a few details of the handling problem, but of exercising the utmost care consistent with commercial work in all operations of picking, hauling, washing, drying, and packing, to prevent injuries, however slight. It necessitates thorough organization of labor and the most careful inspection of work, both in the field and at the packing house. With a view to more clearly emphasizing what constitutes careful handling practice, the various harvesting operations will be discussed separately. The recommendations and directions given are based not only on extensive investigational work, but on results of the most successful commercial practice in the practical handling of citrus fruits for shipment.

HARVESTING, PACKING, AND SHIPPING OPERATIONS.

The operations of harvesting and preparing citrus fruit for market may be divided into two parts—field handling and packing-house

handling. The former includes all the operations of picking, hauling, and delivery of the fruit to the packing house; the latter the operations of cleaning, grading, sizing, packing, and loading. In picking citrus fruits for shipment it is necessary to sever the fruit from the trees by means of clippers

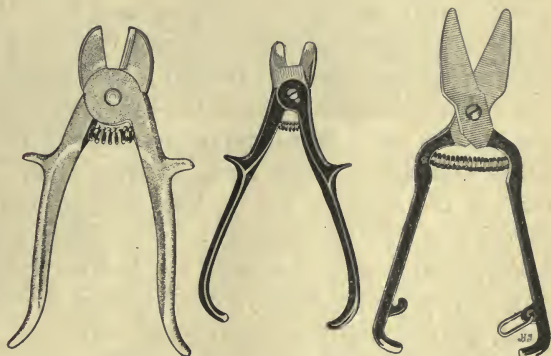


FIG. 2.—Three types of clippers used in picking citrus fruits.

(fig. 2). After the fruit is clipped it is placed in a picking bag or basket, from which it is emptied or transferred to the field box. Much of the fruit in most of the citrus sections, of Florida at least, can not be reached from the ground or from ordinary stepladders, and long ladders placed against the trees are used. The fruit in the field boxes into which it is emptied after being picked is hauled to the packing house on wagons equipped with springs. In the packing house, fruit that is affected with sooty mold, or otherwise in need of cleaning, is either run through dry brushers or through washing machines; thence on to drying racks or through driers to the grading belts. After being graded it is sorted by means of mechanical sizers, each size being run into separate bins for packing. The fruit is then wrapped and packed, according to diagrammatic arrangement, in boxes, and after the covers are nailed on it is ready for loading and shipment.

FIELD HANDLING.

ORIGIN OF INJURIES.

One of the most common as well as most serious types of injuries made in picking is what is known as "clipper cutting." In severing the fruit from the branch the skin is often cut or punctured with the points of the clippers. Oftentimes, in clipping, the clippers leave a long sharp stem on the fruit, and while a long stem does not cause the decay or injury of the fruit to which it is attached, it is as serious as clipper cuts, if not more dangerous than they. A long, sharp, and jagged stem projecting from an orange may injure all the fruit with which it comes in contact in the picking bag, field box, brusher, washing machine, drying rack, packing bin, and the packed box. Long stems are among the most common as well as most serious imperfections in picking.

Considerable injury may also result from pulling fruit that cannot be easily reached for clipping and from shaking the fruit so that it falls to the ground before placing it in the packing boxes. Injuries from thorn punctures frequently result either from high winds before the fruit is picked or through the carelessness of the pickers in handling the ladders or in transferring the fruit to the picking bag. Serious losses and decay result from injuries made by dropping instead of placing the fruit in the picking bag or basket, or, worse yet, by shooting it in; by cutting or scratching the fruit with the finger nails; by squeezing it against the picking ladder while in the picking sack; by carelessly emptying or pouring it into the field box; and by sand, gravel, splinters, protruding nails, etc., in the field boxes. In hauling, additional injury may result from putting too much fruit into the field box, from heaping it so that, in loading and stacking, the boxes rest on the fruit in the box below, and from the hauling of fruit on springless wagons over rough roads.

In the packing house the fruit is subject to injury in numerous ways in the course of the various operations of cleaning, drying, grading, sizing, and packing. The amount of injury inflicted in the packing house will depend both upon the care exercised by the workers and upon the arrangement, character, and state of repair of the packing-house machinery and equipment. The most common causes of injury are rough, careless handling by the workers; poor arrangement of machinery; undesirable types of washing machinery or machines carelessly operated; badly constructed drying racks or inefficient driers, steep gravity inclines or drops; scratches by finger nails in grading and packing; and lack of proper care in packing, nailing, and loading, either in handling fruits individually or in the packing box. The washing of fruit in dirty, infected water and slow or but partial drying serve to infect with the blue-mold fungus every

scratch or injury made either in the field or packing house and to provide ideal conditions for its germination and growth.

PICKING.

Unless the fruit is properly handled in the field at the time of picking, the care exercised in the handling of the fruit in the packing house and the provision of machinery and equipment especially designed to handle the fruit both economically and carefully are largely wasted. The injurious results of bad field handling can not be counteracted or atoned for by providing either the best equipment in the packing house or by exercising the greatest care in packing-house handling.

The amount of injury made in picking depends primarily on the picker and the equipment provided. In order to secure the desired results, the pickers must have a proper appreciation of and know what careful handling means and be supplied with the best tools and equipment obtainable. Given, however, the best of equipment, the care exercised by each picker in all the different operations of picking is the big determining factor. A careless workman will do poor work no matter what his equipment.

All pickers should wear gloves, to guard against finger-nail scratches, and the clippers should be sharp and properly set or adjusted, so as not to leave any ragged fragments in clipping. The points should be dull or rounded, in order to guard against cutting the skin of the fruit when bringing the clipper in position to sever the fruit from the branch. There are on the market several makes of clippers so constructed that while clipper cutting is not impossible, the chances for injury in this way are greatly minimized. In order to do the work properly, especially where the picker must reach some distance for the fruit, the stems should first be cut long and a second cut be made when the fruit is brought to a position where the picker can easily see what he is doing. This method of clipping removes any and all excuse for clipper cutting or the leaving of long stems. While this double cut may take a little longer, practice soon enables a picker to accomplish as much in this way as the other, if quality of work is given equal consideration with quantity.

After the fruit is properly clipped, that is, after the stem is cut off clean and close to the fruit in such a way as not to leave a part protruding, to cut or injure other fruits, it should be placed in the picking bag by hand, not dropped or thrown in, as is too frequently done. The dropping or throwing of the fruit into the picking bag or basket and into the field box is one of the most common and serious causes of injury and resultant decay in transit.

A heavy canvas bag carried from the shoulder by means of a strap and holding not more than half a field box is to be preferred as a picking

receptacle. This bag should be partly closed at the top, making it necessary to place the fruit in the bag by hand, and the bottom should be open but folded up on the side and fastened by hooks or ropes near the top, so as to make a sack or bag. In transferring the fruit to the field box, the whole bag is lowered into the box and the fastening and fold loosened; after which the bag is drawn upward and away, allowing the fruit to roll gently and easily into the field box (fig. 3). This type of bag is preferable to the bushel basket or wicker basket frequently used and to other picking receptacles from which the fruit has to be poured or emptied through the same opening used in picking. With the wicker basket there is a tendency to shoot or



FIG. 3.—Transferring oranges from a picking bag to a field box.

drop the fruit into it in picking and to pour the fruit into the field box rather roughly or carelessly in emptying. Good work undoubtedly can be done even with a basket, but it offers too many inducements for carelessness. The things to guard against in using the picking bag are the danger of bruising the fruit between the ladder and the picker's body and the possibility of thorn punctures through the canvas. If good heavy canvas is used, there is not much risk of the puncturing. Great care should be exercised in handling and setting the ladders, in order to avoid bruising the fruit against the ladder or limbs or scratching it on branches or thorns. Where step-

ladders can be used, they are preferable, but most of the older orange and grapefruit trees in Florida are too high and large for this type of ladder.

USE OF THE FIELD BOX.

The field box in common use in most of the citrus sections of Florida holds approximately one packed box of fruit. It is usually about 28 inches long, 12 inches wide, 13 inches deep, and may or may not have a central upright partition (fig. 3). A common source of injury in field and packing-house handling is the poor condition of the field box. Every box sent into the orchard or grove should be thoroughly inspected, kept in good repair, and free from protruding nails, splinters, gravel, and twigs. A box entirely boarded over on the bottom is pref-

erable, as this prevents injury by stems of weeds and other objects that might otherwise extend into the box and injure the fruit. The boxes should not be filled or heaped to such an extent that any fruit will rise above the end pieces, as where it does the boxes when stacked will rest on the fruit instead of on the ends of the boxes themselves.

This type of field box came into general use through the practice of buying large quantities of fruit on the trees at a fixed price per box. Originally this price was intended to be per packed box, but since it is more convenient to keep the record of the fruit as it leaves the grove, this type of field box, which holds enough fruit to allow culling and still give the buyer a packed box of oranges, was developed. This field box, from the standpoint of careful handling, is not an ideal one by any means. It is too heavy to be handled by one man as carefully as it should be in loading and unloading. In the handling of boxes of this weight and size, they are frequently dropped or set down violently either on the wagon or when unloading in the packing house. A box made of lighter material and holding somewhat less fruit could be handled by one man with much greater ease and care. It is also a question whether a smaller, lighter box would not withstand to a greater degree the "bucking," as it is usually termed, when unloading the empty boxes in the field. The breakage and bad repair of field boxes are due largely to rough, careless handling in disposing of them after emptying or in distributing them in the orchard, where they are often thrown violently and carelessly from the wagon into piles on the ground. Due care should be used in handling the boxes when filled, in order not to injure the fruit in them, but equal care is required in the handling of the field equipment when empty, in order to guard against breakage, splintering, etc.

HAULING.

The wagons on which the fruit is hauled should always be provided with good springs, and no fruit, under any circumstances, should be hauled on springless wagons, no matter how good the roads may be. The driver should be provided with a special seat, leaving him no excuse for riding on top of the load or on the fruit itself. The field boxes should be properly loaded and stacked, and if necessary the load should be thoroughly roped to prevent the shifting of the boxes, and the utmost care should be used both in loading and unloading to guard against unnecessary jolting or rough handling. Where boxes of the heavier types are used, it is not an infrequent occurrence to see them set down or dropped with such force as to cause considerable fruit to bound out on the floor of the packing house. Care in handling the fruit both in the field and packing house is oftentimes largely nullified by careless, rough handling in hauling and unloading.

SUPERVISION AND PAYMENT OF PICKING CREWS.

Where the picking is done by picking crews hired by the grower, shipper, or marketing organization, a good reliable foreman should be secured, and it should be the duty of this foreman to see that all pickers do their work carefully and properly, that the clippers are in good condition, that the picking boxes are in good repair, and generally to supervise the quality of work in field handling. In order that he may know just what kind of work his pickers are doing, he should make frequent inspections of each man's work, ascertaining by actual count his percentage of clipper cuts, long stems, and other injuries and imperfections. These duties, if properly and conscientiously performed, will require all his time, and in most cases he should not be required to do any picking. The payment of pickers by the day, instead of by the box, is preferable from the standpoint of securing careful and proper work, as box or piece labor usually puts a premium on quantity primarily. Careful inspection of the character of work secured under the two systems of labor payment has conclusively shown that the pickers working by the day average on the whole much better work. On the other hand, good work can be secured with either the box-payment or day-payment plan if the labor is properly supervised. The character of work done by a picking crew depends on the foreman, and the responsibility for the field handling rests primarily with him. An efficient foreman can secure careful work under either system of payment, though much more easily and surely where the pickers are paid by the day.

RELATION OF FIELD HANDLING TO COOPERATIVE AND ORGANIZED MARKETING.

The importance of proper field handling is fully recognized by most cooperative and marketing organizations which attend to the preparation of the fruit for market as well as the selling and distribution end of the business. The fruit brought into an association packing house during any one day usually comes from a great many growers in the surrounding territory, and after it has been properly weighed and graded it loses its identity as far as the grower is concerned. This means that each car shipped may contain fruit from a great many growers. Careful investigation of the character of work performed by different picking crews, especially where the picking is done by the growers or under their direction, has shown that there is a great difference in the kind of work being done. One grower may pick his fruit with the greatest possible care, while his neighbor may do exactly the opposite. The fruit from both growers may be shipped in the same car, the carefully handled fruit arriving in sound condition, the fruit carelessly handled developing much decay in transit and at the market. The poor work of one grower in picking in this way nullifies to a considerable extent the good work of the other.

The different associations have therefore found it to their advantage, and in most cases necessary, to take over and assume full responsibility for the field handling of their growers, through employing trained crews properly supervised to do the picking. This insures uniformity in the handling of the fruit of all growers throughout all the harvesting operations and serves to place all growers on the same and a just basis. Practical experience and careful investigation of the facts in the matter have conclusively shown this to be the most satisfactory way of managing the field end in an organization handling citrus fruits from several growers, especially if the fruit from the different growers is pooled or shipped in the same car. The merchantable condition of the fruit depends primarily upon the kind of handling given it in preparing it for market. Commercial



FIG. 4.—A two-story building with excellent facilities for packing and shipping citrus fruits.

experience has shown that it is almost impossible to secure uniformly good results where the picking and field handling are left to the individual grower. Even if the grower realizes the necessity for careful handling, he does not always know just what careful handling means or the seriousness of injuries in handling, nor can he employ the trained labor or supervise it to the extent possible where the crews are employed by an association or organization throughout the harvesting season.

PACKING-HOUSE HANDLING.

Wherever possible, it is desirable to locate the packing house near the railroad, in order that the fruit after it is packed can be loaded directly into the car from a loading platform without further hauling or loading and unloading from a wagon (fig. 4). No attempt will be

made to give definite plans for a packing house, as the size, equipment, arrangement, etc., must necessarily depend on the quantity and character of fruit to be handled. In general, it may be said that the best packing house is not necessarily the one that has the most machinery in it or that costs the most. The size of a packing house and the character of its equipment will depend largely upon the amount of fruit to be handled and whether the fruit has to be washed or cleaned. In equipping and arranging the machinery the one thing that should be kept in mind more than any other is simplicity. The fruit should be kept on one level as much as possible, from the hopper or washing machine to the packing bins (fig. 5). Gravity runs, drops,

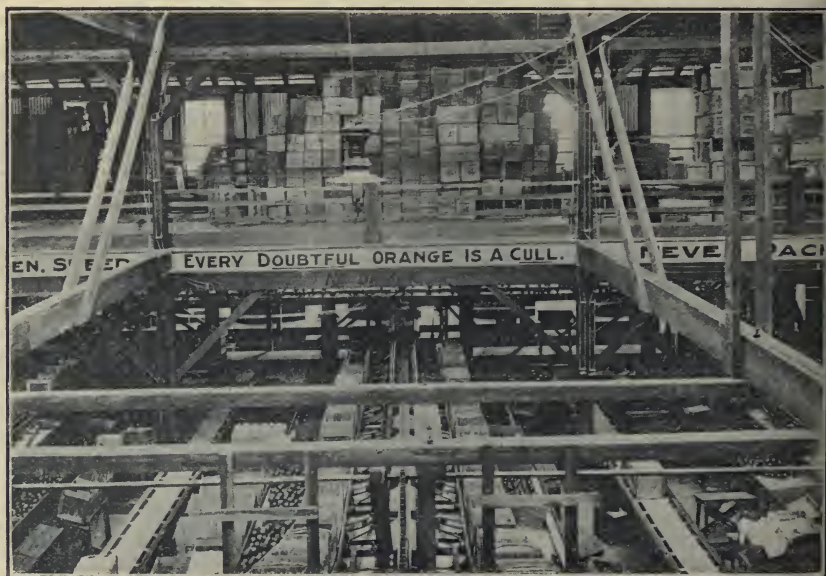


FIG. 5.—Interior of a well-arranged packing house. Note the grading belts in the rear in the well-lighted portion of the house, the carrier, or chute, for empty boxes above the packing bins, the stands for the packing boxes, and the carrier for the packed fruit.

and sharp turns or angles should be avoided as far as possible. At no point in the handling operations should the fruit actually be dropped more than 3 or 4 inches; in fact, practically no drop is necessary, if the house is properly arranged, with the exception of the drop from the sizers into the packing bins, and 3 inches should be the maximum even here. A well-lighted packing house is essential to proper grading and good work generally. The importance of good sanitation and of keeping the house absolutely clean and free from rubbish and decaying fruit can not be overestimated. Decayed fruit in or near the packing house is a prolific source of blue-mold infection and a sure indication of inefficient or indifferent management.

Sufficient room should be provided inside the house for stacking the fruit hauled in from the orchard and for packed fruit awaiting loading. Space ordinarily is provided in the second story for box hooks and the making of them into boxes. Gravity runways or chutes can easily be provided for carrying the made-up boxes down to the packing room, where they can be easily reached by the packers.

USE OF THE HOPPER.

Where washing is not necessary, the fruit is usually first emptied into a hopper, after which it passes either over dry brushes or directly to the grading belts. A hopper holding not more than two boxes of fruit is desirable. It should be well padded and have only sufficient slant to provide for the easy movement of the fruit. In emptying from the field box to the hopper, the greatest care should be exercised to transfer the fruit without dropping it or throwing it any distance. This operation can be accomplished with little or no injury either by holding the fruit back with the arm or hands in emptying or by using a canvas cloth to hold the fruit back, so as to allow it to roll out easily and gently from the box into the hopper.

Considerable injury is often caused by carelessly emptying or virtually throwing the fruit from the field box into the hopper and by the use of hoppers that are altogether too large. Not only should the utmost care be exercised in placing the fruit in the hopper, but the hopper itself should be kept absolutely free from twigs, gravel, sharp edges, or protruding nails that would injure the fruit placed in it. Formerly very large hoppers were used, frequently holding a wagonload or more of fruit, the grading being done at the lower end of the hopper before the fruit passed to the sizing machine. This type of equipment, however, has been almost entirely replaced by the smaller hopper and canvas or roller conveyer belts for grading.

WASHING AND CLEANING.

In many sections of the Gulf coast region where citrus fruits are grown, the washing or cleaning of the fruit prior to packing is absolutely necessary, in order to remove the sooty-mold fungus which follows the attacks of the white fly and other insects. Washing will continue to be one of the necessary handling operations until the growers make the necessary steps to control the white fly in citrus groves and to grow clean, bright fruit. If it were possible to do away with washing entirely, a great deal of decay occurring in citrus fruits in transit and while being held on the market could be prevented. There is little or no question that if the losses resulting from the washing and drying operations could be saved, the expense of time and money necessary to grow clean fruit would be more than compensated for.¹

¹ For information regarding the control of the white fly and other insects which attack citrus fruits, write to the Bureau of Entomology, Department of Agriculture, Washington, D. C. The agricultural experiment stations located in the States where citrus fruits are grown will furnish bulletins and information in reference to the control of insects.

However, if the fruit is in such condition that it has to be washed, it is essential that every precaution be taken to perform this operation in such a way as to inflict as little injury as possible on the fruit as it passes through the washing machine. Washing and drying are the most complicated processes through which the fruit is put in a packing house, and these combined operations involve a great deal of extra handling, which furnishes additional opportunities for mechanical injuries. Extensive investigations have shown that the decay in packed fruit is largely due to injuries received or aggravated during the operations of washing and drying, and the bad effects following washing are due not so much to actual injuries made in passing fruit through the machine as to the inoculation of injured and bruised spots with fungous spores through the agency of dirty and infected water. Injuries made in the grove or in other operations of handling, or injuries made as the fruit passes through the machinery, are aggravated by the addition of moisture, especially when the water is not clean.

The three main causes of decay following the washing and drying operations are (1) dirty and infected water in the soaking tank, (2) poorly constructed or operated washing machinery, and (3) the slow or but partial drying of the fruit under unfavorable climatic conditions. The first can largely be obviated by the proper handling of the fruit in the field and in hauling, so as to bring it to the washer in sound, uninjured condition, and by frequently changing the water in the washing tank, or by the elimination of the washing tank entirely where possible and the substitution of a spray before the fruit reaches the washing machine, in addition to the spraying of it as it goes through or over the brushes. Where the fruit is badly covered with sooty mold, a soaking tank is almost a necessity. Where used, the water should be changed frequently, at least two or three times a day. No definite or particular make of washing machine can be recommended, but, in general, the following points and requirements should be kept in mind:

The fruit should be constantly in plain sight while going through the washing machine; there should be no pressure or weight on top of it or any considerable pressure laterally, the cleaning being done entirely by the weight of the fruit itself in passing over the brushes or other cleaning devices (fig. 6).

There should be little or no opportunity for the fruits to tumble over or rub against one another.

It is essential that the machine be kept thoroughly clean and free from twigs, protruding nails, or anything of that sort that would injure fruit going through it.

After having selected a machine of the type fulfilling as nearly as possible these requirements, the amount of injury incurred in washing will depend largely upon its operation and upkeep. Frequent inspection of the machine is desirable, in order that the worn-out

brushes may be replaced with new ones. Without such inspection from time to time, some little thing may get out of order that will cause an enormous amount of injury and consequent decay of fruit.

DRYING.

After the fruit has been washed, it may be run through dry brushes or directly to a drier or to drying racks. Of late, most of the packing houses, at least the larger ones, have substituted artificial driers for the drying racks so common a few years ago. A drying rack, if properly handled and placed, may from some standpoints be satisfactory.

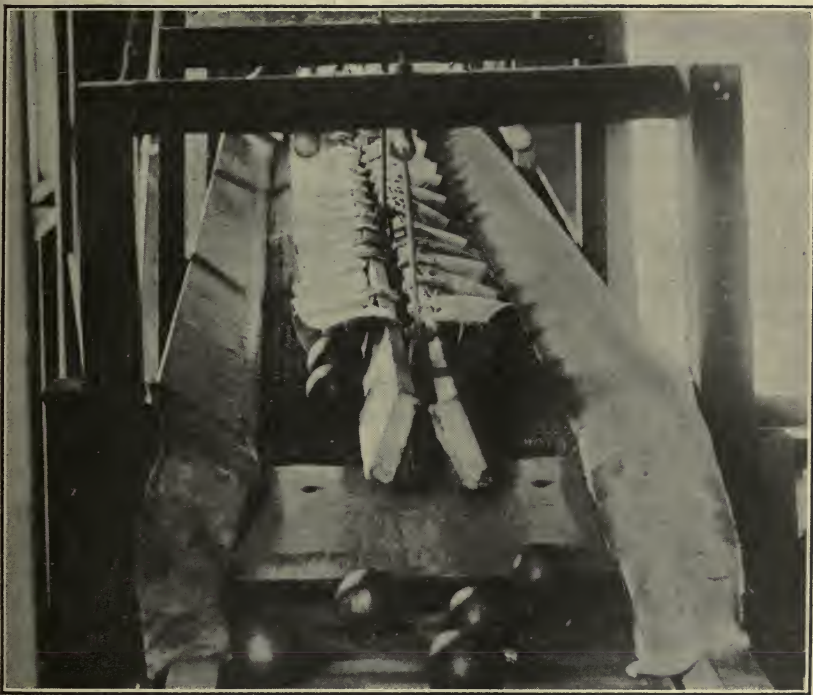


FIG. 6.—A type of washer in common use for cleaning citrus fruits.

If placed outside of the packing house, drying can be done only during favorable weather. To place the drying rack inside the house means the elevation of the fruit a considerable distance and the rolling of this fruit down rather steep gravity runs. It is almost impossible to keep such devices free from splinters and to handle the fruit on them without inflicting more or less injury.

The artificial driers now in use are open to somewhat the same objection, in that they do not do satisfactory work under the most unfavorable climatic conditions or during prolonged periods of rainy weather. Great improvements in driers, however, are constantly

being made, and, where properly handled, more satisfactory work can be obtained with artificial driers than with the ordinary drying racks. These driers are usually made in the form of a long box, through which the fruit is carried on roller conveyers one or more times. The drying is accomplished by forcing a considerable volume of air through this box either from one end or, more commonly, from several points along the sides or top or through the bottom of the drier, in order to distribute the air more evenly. Under dry, sunshiny conditions, the ordinary air usually serves the purpose, but during cloudy and rainy weather it is necessary to heat the air somewhat, in order to accomplish thorough drying during the time the fruit is passing through the drier. Under very unfavorable climatic conditions, such as occur frequently during the harvesting and picking season, it is exceedingly difficult to do thorough drying, even with warm or heated air.

It is of the greatest importance that the fruit be thoroughly and quickly dried. The blue-mold spores require moisture for germination, and if the fruit is left for any length of time in a moist condition, or if packed while still wet, ideal conditions for the germination of these spores are provided, and if any of the oranges are injured decay is certain to result.

GRADING.

The fruit is usually run on to grading belts directly from the drier. These grading belts may be either of canvas or in the form of roller conveyers which keep turning the fruit as it passes before the graders. In order to do grading properly, it is necessary to have good light. This point can hardly be overemphasized, as one of the most common mistakes in building a packing house is to provide insufficient light for grading. Generally speaking, there are no uniform rules for grading oranges and grapefruit in Florida, and, as a rule, only two classes are made—brights and russets. In the bright class, or first grade, is placed all bright, well-colored fruit, while the second grade, or russet, is usually composed of fruit more or less affected by the work of the rust mite, by melanose, or by other skin blemishes. The finest of the brights may be packed as "Fancy" or some of the brightest russets may be labeled "Golden." Sometimes, however, similar grades of fruit from different packing houses may be sold under entirely different grade names. The tendency now is to establish more uniform regulations regarding grading, to market certain grades under established brands, and never to ship under such brands any but fruit coming up to the specified grade.

The grading of the fruit, however, is entirely without reference to the size of the fruit. Whatever grades are made or established, it is of the greatest importance that the grading rules be strictly adhered to and that the first grade contain no fruit except such as is clean and

free from blemish and which comes up to the first-grade requirements in every way. If there exists any doubt regarding the grade in which the fruit is to be placed, it is preferable to place it in a lower rather than in a higher grade. The uniformity of grading and the dependability of grades do much to establish the reputation of particular brands on the market. Good grading goes hand in hand with good, careful work in the other operations of harvesting and handling.

SIZING.

In equipping a packing house, separate sizers are usually provided for each grade and one bin for each size of a grade. After the fruit is properly graded it continues on either canvas or roller conveyer belts to the mechanical sizers and thence into the packing bins. The sizers should be selected primarily with reference to the accuracy of sizing and the ease with which the fruit is handled, and great care should be exercised in constructing and arranging the bins to guard both against long drops from the sizer to the bin and the piling up of fruit in the portion of the bin next to the sizer to such an extent as to interfere with the proper sizing of the fruit. Accuracy in sizing is of great importance in determining the appearance of the pack and the price paid for the fruit at the market end. Good fruit, uniformly well graded and sized and in sound condition, soon gains a reputation for soundness, quality, and dependability that commands for it the highest market price throughout the season.

PACKING.

Good packing involves both science and art. Next to soundness and keeping quality, the appearance and attractiveness of the pack are the greatest factors in determining the market price of fruit, and it is therefore of the greatest importance that this part of the handling operations be carefully and efficiently supervised. During the last few years attempts have been made to put up what are called bulge or high packs, as against the former practice of putting up a pack that was practically flat and even with the ends of the box. While a high pack is desirable, at least from a marketing standpoint, there are certain features and methods of procuring such a pack that should be kept clearly in mind. Oftentimes the fruit is packed loosely in the box, the last layer protruding considerably above both ends and sides of the packing box, the bulge being obtained by squeezing the fruit down at the ends when nailing on the cover. However, even though the fruit may have the desired appearance at the time it is loaded into the car, it settles in transit and when it arrives on the market the box is slack and has a very poor appearance. The squeezing of the fruit down into the ends of the box by means of the cover also results in a great deal of injury and decay in transit.

The best pack for all purposes is a firm, moderately high one, all of the fruit being packed in tightly from bottom to top. After some experience the packer will have no difficulty in securing the desired bulge with this firm pack. If the fruit throughout is firmly and tightly packed and it remains in sound condition, the pack will not become slack in transit, as is the case where the fruit is rather loosely packed in the bottom of the box.

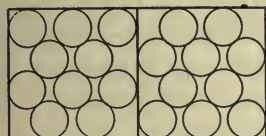
Considerable injury is done by dragging the oranges around in the bins and tossing the off sizes into neighboring bins. Every packer should wear a glove, at least on the hand which picks up the fruit, so as to avoid finger-nail scratching. The packing bin should be thoroughly padded and kept free from dry twigs and other trash, and the drop from the sizer to the bin should be the shortest possible.

In the packing of citrus fruits, each fruit is wrapped in thin wrapping paper, different sizes of paper being used in accordance with the size of the fruit being packed. In wrapping citrus fruits preparatory to packing, the stem should always be placed in the twist of the paper and the fruit should be tightly wrapped in such a manner that the paper will not fall off from the fruit when taken out of the box, without being removed by hand. Poor wrapping and inattention to placing the stem of the fruit in the twist are but another sign of careless work and inefficient management. The name of the grower, association, or marketing organization, with its brand or trade mark, is very frequently printed on the wrapping paper. Some houses pack all but the bottom and top layers in plain papers, using the paper with the brand printed on it only for the top and bottom layers. It would seem, however, to be more consistent and preferable to use the printed paper throughout the package, if at all. The usual sizes of round oranges run from 96 to 288, the more common sizes being 126, 150, 176, 200, and 216 to the box. Figure 7 gives a diagrammatic representation of the method of placing the fruits of various sizes in the packing box. The arrangement as shown in the box end to the left is that for the first or the bottom layer; the one on the right is the second layer, which is placed on top of the first. The third layer is the same as the first, and the fourth the same as the second, and so on.

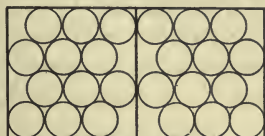
Figure 8 gives a diagrammatic illustration of the method of packing grapefruit of the different sizes, with the arrangement of fruits in each layer, the number of layers in each end, and the approximate diameters as ordinarily used. Certain sizes are oftentimes packed differently from the arrangement shown in the diagram, the packs here illustrated being the ones more commonly used and preferred at the present time. The sizes and number of grapefruit in a box may vary from 18 to 96, the most common sizes usually running 46, 54, 64, and 80 to the box. The diameters given both for oranges and grapefruit

are average diameters only, these being varied somewhat in accordance with the shape of the fruit and the tightness of pack desired. The boxes commonly used for either oranges or grapefruit contain a space of almost exactly 2 cubic feet, the outside measurements approximating $12\frac{1}{2}$ by $12\frac{1}{2}$ by 27 inches.

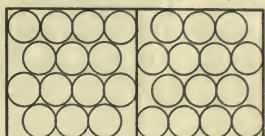
80s; diameter $4\frac{1}{2}$ inches; 4 layers. 96s; diameter 4 inches; 4 layers. 112s; diameter $3\frac{1}{2}$ inches; 4 layers.



10 fruits. Layers 1 and 3.

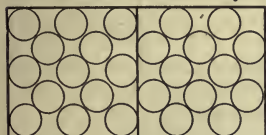


12 fruits. Layers 1 and 3.



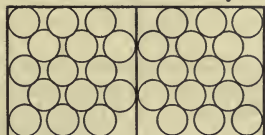
14 fruits. Layers 1 and 3.

126s; diameter $3\frac{1}{2}$ inches; 5 layers.



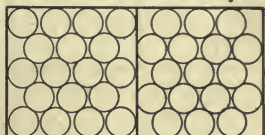
13 fruits. Layers 1, 3, and 5.

150s; diameter 3 inches; 5 layers.



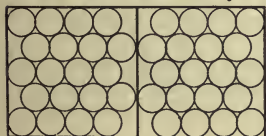
15 fruits. Layers 1, 3, and 5.

176s; diameter $2\frac{7}{8}$ inches; 5 layers.



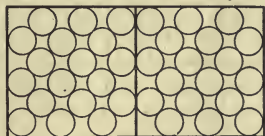
18 fruits. Layers 1, 3, and 5.

200s; diameter $2\frac{3}{4}$ inches; 5 layers.



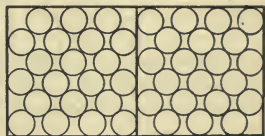
20 fruits. Layers 1, 3, and 5.

216s; diameter $2\frac{1}{2}$ inches; 6 layers.



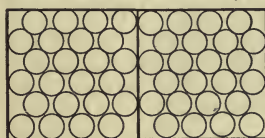
18 fruits. Layers 2, 4, and 6.

252s; diameter $2\frac{1}{4}$ inches; 6 layers.

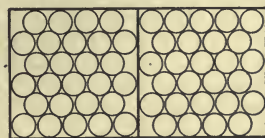


21 fruits. Layers 1, 3, and 5.

288s; diameter $2\frac{1}{2}$ inches; 6 layers. 324s; diameter 2 inches; 6 layers.



24 fruits. Layers 1, 3, and 5.



27 fruits. Layers 1, 3, and 5.

FIG. 7.—Diagrams illustrating the arrangement and methods of packing sweet or round oranges of different sizes in layers in standard boxes. The number of fruits and the approximate diameter of each fruit in the box and the number of layers in each end are given above each diagram. The number of fruits in each layer is shown below the diagram.

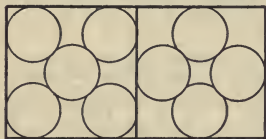
SIZING AND PACKING MANDARIN ORANGES.

Tangerines, mandarins, and King and Satsuma oranges are usually packed in half boxes, or "straps." The sizes for these fruits usually run from 48 to 216, the most common sizes being intermediate between these two. Figure 9 illustrates the arrangement of various sizes of these fruits in packing. There is some variation in different sections, of course, in the method of packing these sizes, the arrange-

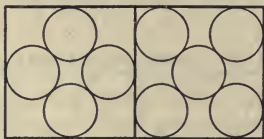
ments illustrated being the ones in most common use. In shipping, two of these boxes are usually strapped together and loaded the same as one box of round oranges or grapefruit.

In the Mobile section of Alabama and other districts of the Gulf coast where Satsuma oranges are grown on a considerable scale, more attention is being given to the development of distinctive Satsuma packs. The methods of packing Satsuma oranges in the sections outside of Florida are very similar to those illustrated for mandarin oranges. Practically the same box is used, one measuring approximately 12 by 6 by 24 inches inside measurement and having a capacity

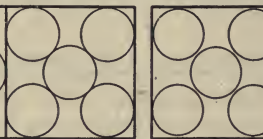
28s; diameter 6 inches; 3 layers. 36s; diameter 5½ inches; 4 layers. 46s; diameter 5 inches; 5 layers.



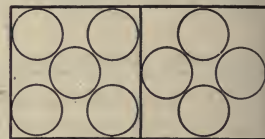
5 fruits. Layers 1 and 3.



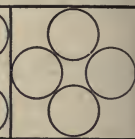
4 fruits. Layers 1 and 3.



5 fruits. Layers 2 and 4.

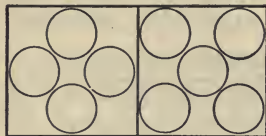


5 fruits. Layers 1, 3, and 5.



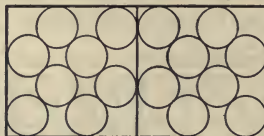
4 fruits. Layers 2 and 4.

54s; diameter 4½ inches; 6 layers.



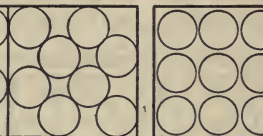
4 fruits. Layers 1, 3, and 5.

64s; diameter 4½ inches; 4 layers.



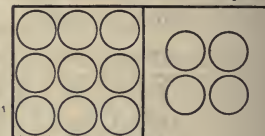
8 fruits. Layers 1 and 3.

70s; diameter 4½ inches; 5 layers.



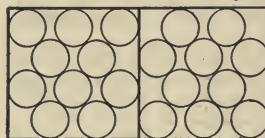
9 fruits. Layers 1, 3, and 5.

70s; diameter 4½ inches; 5 layers.



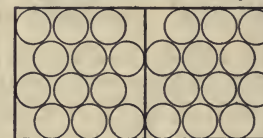
4 fruits. Layers 2 and 4.

80s; diameter 4½ inches; 4 layers.



10 fruits. Layers 1 and 3.

96s; diameter 4 inches; 4 layers.



12 fruits. Layers 1 and 3.



12 fruits. Layers 2 and 4.

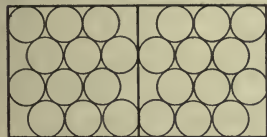
FIG. 8.—Diagrams illustrating the arrangement and methods of packing grapefruit of different sizes in layers in standard boxes. The number of fruits and the approximate diameter of each fruit in the box and the number of layers in each end are given above each diagram. The number of fruits in each layer is shown below the diagram.

of 1 cubic foot. The arrangement of the packs is essentially the same, the principal difference being that the sizes generally run about one-quarter inch larger than those given in figure 9. This necessitates somewhat tighter packing and tends to give the pack a considerable bulge. In addition to the packs illustrated in figure 9, packs with 240 and 288 fruits to the box are used to some extent. The fruits in the 240 pack have a diameter of 2½ inches and are packed 4 and 4 in six rows of five layers. In the 288 pack the oranges having a diameter of approximately 2½ inches are packed 4 and 4 in six rows of six layers.

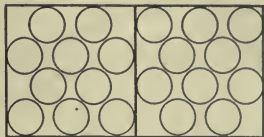
NAILING.

Many modern packing houses, especially the larger ones, have installed roller conveyers or some other conveyer device for carrying the packed box from the packer to the nailing bench. Where these are provided, all that the packer has to do is to remove the box from the inclined bench holding the packed box to the conveyer alongside.

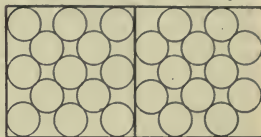
48s; diameter $3\frac{3}{4}$ inches; 2 layers. 60s; diameter $3\frac{1}{2}$ inches; 3 layers. 76s; diameter $3\frac{1}{4}$ inches; 3 layers.



12 fruits. Layer 1. 12 fruits. Layer 2.

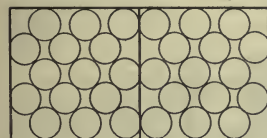


10 fruits. Layer 1 and 3. 10 fruits. Layer 2.

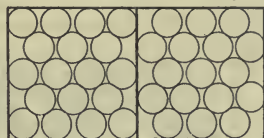


13 fruits. Layers 1 and 3. 12 fruits. Layer 2.

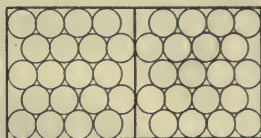
90s; diameter 3 inches; 3 layers. 106s; diameter $2\frac{7}{8}$ inches; 3 layers. 120s; diameter $2\frac{3}{4}$ inches; 3 layers.



15 fruits. Layer 1 and 3. 15 fruits. Layer 2.

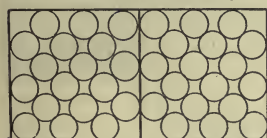


18 fruits. Layer 1 and 3. 17 fruits. Layer 2.

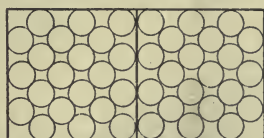


20 fruits. Layer 1 and 3. 20 fruits. Layer 2.

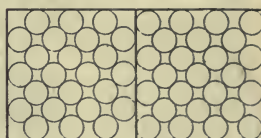
144s; diameter $2\frac{1}{2}$ inches; 4 layers. 168s; diameter $2\frac{1}{2}$ inches; 4 layers. 196s; diameter $2\frac{3}{4}$ inches; 4 layers.



18 fruits. Layer 1 and 3. 18 fruits. Layer 2 and 4.

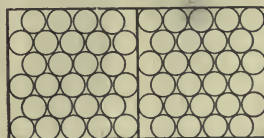


21 fruits. Layer 1 and 3. 21 fruits. Layer 2 and 4.



25 fruits. Layer 1 and 3. 24 fruits. Layer 2 and 4.

216s; diameter, $2\frac{1}{4}$ inches; 4 layers.



27 fruits. Layer 1 and 3. 27 fruits. Layer 2 and 4.

FIG. 9.—Diagrams illustrating the arrangement and methods of packing mandarins, tangerines, and King and Satsuma oranges in layers in standard half-size boxes or straps. The number of fruits and the approximate diameter of each fruit in the box and the number of layers in each end are given above each diagram. The number of fruits in each layer is shown below the diagram.

The cover may be nailed on, either with or without the use of a press (fig. 10). In either case great care should be taken in putting on the cover to prevent injury to the top layer as the fruit is necessarily pressed down at the ends and the sides. If the center of the box and the inside edges of the ends, as well as the sides of the box, are beveled, the liability to injury in putting on the cover is very much decreased.

Formerly all the boxes were bound with three wooden straps, one around each end and one around the middle. While these still are being used to a considerable extent, metal straps have come into quite general use. These straps are usually nailed on three sides when the box is made up and looped over the top and firmly nailed



FIG. 10.—A box press used for putting on the cover of a packed box of citrus fruits.

in place after the cover has been put on. In some of the packing houses the end straps are omitted entirely.

LOADING.

It is of great importance that the boxes be so loaded in the car that there will be no shifting or breakage in transit. The fruit is often

loaded either on end or on the side, without cleating or bracing. A safer and better method, however, is to load all boxes on end two tiers high throughout the car. The most common loads are 300, 330, and 360 boxes. The 300 load is secured by loading five rows across, 30 boxes long and 2 boxes high. The 360 load is secured by loading six rows across, 30 boxes long and 2 boxes high. In loading 330 boxes in a car the bottom tier is the same as with 360, while in the upper tier some of the boxes are usually laid on their sides through the middle of the car. Each row should have two substantial car strips nailed across the ends of the boxes, one strip being shoved tightly up against the car wall on one side, while the other strip on the same row of boxes should be placed tight against the opposite car wall. If this method is used, it will prevent the shifting of the load in any direction.

CURING.

In some citrus sections of the Gulf coast region the curing or holding of oranges and grapefruit for a few days prior to packing and shipping is still practiced. The principal arguments in favor of curing have been that the holding of the fruit for a considerable time in the packing house will permit the throwing out of fruit predisposed to or showing decay and the putting up of a tighter, firmer, and more attractive pack, owing to the greater pliability of the fruit. The arguments do not seem to be well founded and the practice itself seems to be not justified. Both investigational and commercial results have clearly demonstrated that because of the slow development and growth of the blue-mold fungus the decay ordinarily does not develop sufficiently during the curing period to be distinguished and thrown out by the graders. Moreover, delayed fruit, mechanically injured almost without exception, shows considerably more decay both on and after arrival at the market than similar fruit packed and shipped immediately. As regards the claim that wilting or curing is necessary in order to put up a tight, firm pack without injury, practical experience has demonstrated that a pack fully as firm and as attractive in appearance can be put up the same day the fruit is picked from the tree. The holding of the fruit in the packing house during a curing period permits added opportunity for infection and affords ideal conditions for the development of blue-mold decay in transit and at the market. In view of the increased decay that is likely to result from curing and the entire practicability of putting up without injury a tight, firm pack without wilting or curing, all citrus fruits except lemons and perhaps limes should be shipped as soon as possible after removal from the tree.

METHODS OF SHIPMENT.

Citrus fruits from the Gulf States may be transported by several routes and under as many methods of shipment. The great bulk

of the fruit from Florida and the other older citrus sections in the Gulf States is shipped by rail in full carload lots under either ventilation or refrigeration. Small consignments are sometimes forwarded either by express or by freight to near-by and distant markets or to assembling points for reshipment either by rail or by water. Considerable fruit is shipped by water from Jacksonville, Savannah, and other Gulf coast ports and from points on the Mississippi River in Louisiana.

REFRIGERATION.

Up to within a few years, practically none of the citrus-fruit shipments from Florida were carried under refrigeration. The prevailing opinion has been that citrus fruits do not need refrigeration, especially as most of the crop is moved during the winter months when the outdoor temperatures in all but the Gulf States are low; so low, in fact, that the problem has been to protect the fruit against freezing. In order to avoid, as far as possible, damage by freezing, citrus fruits are now almost universally transported in refrigerator cars whether under ventilation or refrigeration.

During the warmer periods of the shipping season and during periods when decay is unusually heavy, a considerable proportion of the shipments are now iced. The shippers generally claim that shipments under refrigeration, especially during such periods as are above mentioned, arrive in sufficiently better condition to more than offset the added cost. There is little or no question regarding the value of refrigeration for citrus fruits under certain conditions; nevertheless, there are certain points that should be kept clearly in mind.

The investigations of the Department of Agriculture have conclusively demonstrated that oranges and other citrus fruits can be transported to market under ventilation with the minimum amount of decay, even during periods of warm, humid weather, provided sufficient care is exercised to preserve the skin of the fruit in a sound, unbroken condition. The use of refrigeration in transit can not be depended upon to offset the effects of rough or careless handling. The low temperatures secured by icing may arrest or retard the development of decay fungi only to have decay develop rapidly after unloading or exposure to warmer temperatures. Thus, while the fruit may arrive in practically sound condition, it will gain a reputation for poor market-holding quality if it has been injured by careless handling. It is fully as important in the long run that fruit possess good keeping quality on the market as that it arrive in sound condition.

It should also be kept clearly in mind that the cooling of the fruit in a refrigerator car even where the ice bunkers are full is exceedingly slow. Extensive investigations of temperatures of citrus fruits in transit under various methods of shipment have shown that it takes

five to seven days for the ice in a refrigerator car to bring the temperature of all of the fruit in the car down to a point where ice can maintain it. During the first part of the journey a great deal of the fruit is not cooled to any considerable extent, permitting the germination and growth under very favorable moisture conditions of blue-mold and other decay organisms. If these fungi start growth and development during the first part of the journey, while the temperatures in most portions of the car are relatively high, the lowest temperatures that can be maintained in an iced car will not entirely retard further growth and development.

PRECOOLING.

Precooling is the term employed to designate the quick and prompt cooling of fruits, vegetables, and other produce prior to shipment. The primary object of precooling is obviously the delivery of perishable produce at the markets in a fresher, sounder, and more wholesome condition than is possible under either ventilation or ordinary refrigeration. If precooling properly done fails in this respect or does not bring increased returns commensurate with the extra expense involved, it is not justifiable from a commercial or any other standpoint.

As already pointed out, under ordinary refrigeration the rate of cooling is exceedingly slow, the ice being required not only to take the heat out of the fruit but also to take up the heat leakage through the car walls. On the other hand, if the fruit is thoroughly cooled before shipment, the ice has only to maintain low temperatures against the leakage of warmer air through the car. One of the main objects of the prompt cooling of citrus fruits in the Gulf States is to prevent the germination of blue-mold spores and to retard or arrest the development of stem-end decay. While blue mold will continue to grow and develop at temperatures even as low as freezing, spore germination takes place but slowly at 40° F. The stem-end decay fungus grows and develops but slowly at temperatures below 40°, and it is not very active at temperatures between 40° and 50° F. The beneficial effects, therefore, of precooling citrus fruits as regards decay in transit and on the market result from the provision and maintenance of low temperatures unfavorable to any but slow germination of fungous spores and to the growth of fungi such as cause blue mold and stem-end decay.

Precooling, like refrigeration, should not be depended upon to overcome the injurious effects of rough and careless handling. However, during the citrus shipping season there oftentimes occur periods of extremely rainy, warm, and unfavorable weather when fruits are not only unusually tender but when practically every injury results in decay. The problem of commercially handling citrus fruits

so as to preserve the skin of the fruit in a sound, unbroken condition is, to say the least, under such conditions most difficult. Where the trees are thorny and full of dead wood, some injury is bound to occur, either through high winds before picking, or in placing the ladders, or in removing the fruit from the tree. It is during warm, moist periods that stem-end decay is frequently most severe. Refrigeration in transit is employed, more especially when fruit has been handled under unfavorable weather conditions, to retard the growth and development of the fungous organisms causing decay. While the decay on arrival has been somewhat lessened through the use of refrigeration, the rapid development of decay after the arrival of the fruit on the market makes refrigeration sometimes of doubtful value.

It is during such unfavorable weather conditions, when high decay occurs in a great many shipments, and during the warmer weather toward the end of the shipping season that precooling should be of greatest value.

Precooling citrus fruits in the Gulf States had not been attempted either experimentally or commercially prior to the season of 1913-14, although it has had considerable commercial application in the citrus and deciduous fruit districts of California for a number of years. During the last two seasons the Department of Agriculture has conducted extensive and careful investigations of the relationship of precooling to the decay of Florida oranges in transit and on the market. The results of these investigations and the results obtained in commercial plants erected prior to the opening of the 1914-15 season indicate that precooling is a valuable aid to careful and proper handling in insuring sound condition on arrival and for a period of about 10 days after arrival at the market. Proper handling with precooling may be the means of insuring the delivery of sound oranges throughout the whole shipping season. One of the most difficult problems heretofore has been that of uniformly placing the fruit on the market in good, sound condition and the establishing of a reputation for dependable keeping quality throughout the season. Both the investigational and commercial results indicate that precooling has peculiar application in the transportation of citrus fruits, especially oranges, from the Gulf States, particularly in view of the fact that during the greater part of the season precooled shipments can be forwarded with initial icing only. During about three months in the winter the maintenance of low temperatures in transit is entirely practicable by thorough precooling, even without initial icing or icing en route. Even where initial icing is used in the transportation of precooled shipments the combined cost of precooling and initial icing is considerably below the average cost of full refrigeration.

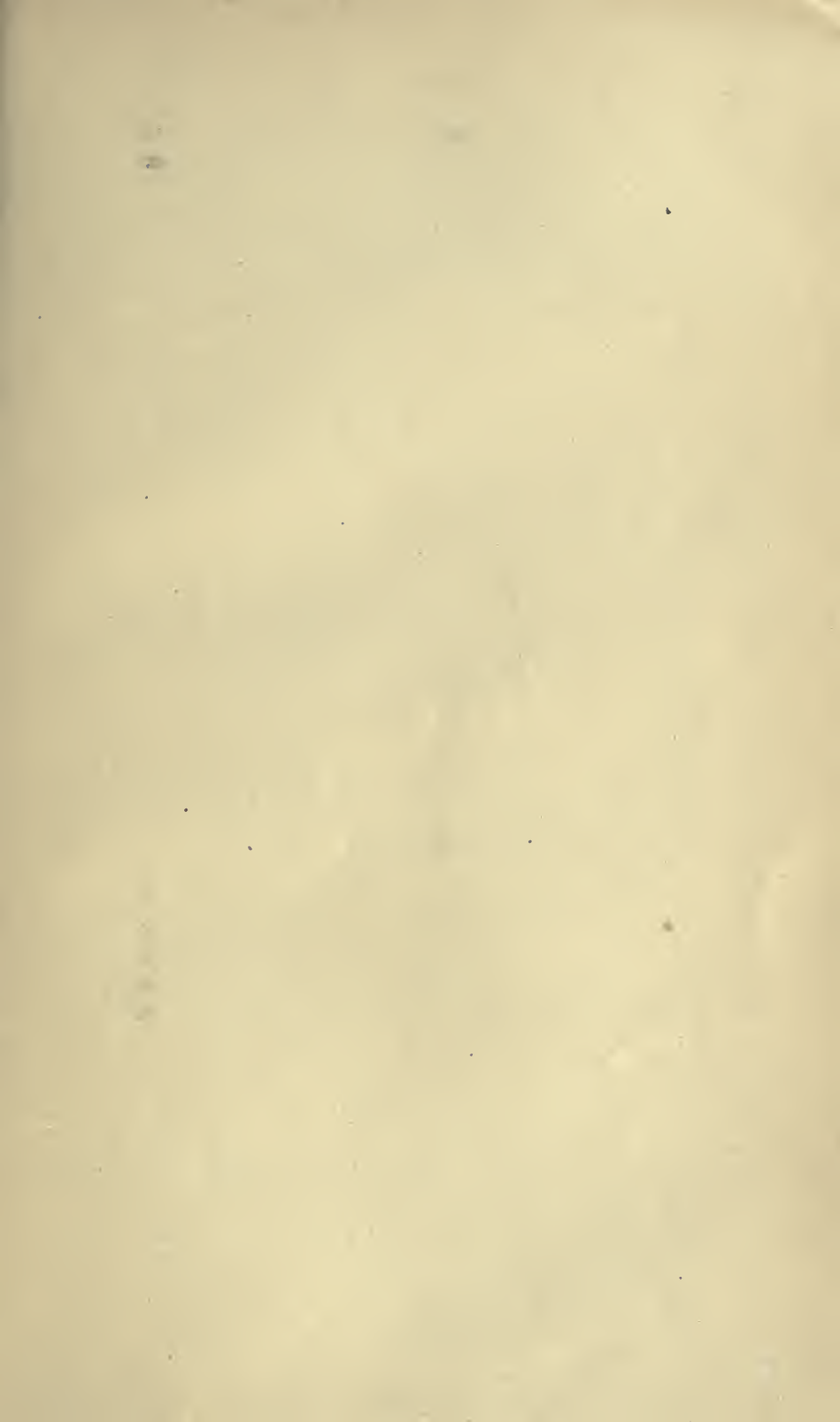
In general, there are two ways of doing precooling, the car or the warehouse method. In car precooling the fruit is first loaded into a refrigerator car ready for shipment, after which cold air is circulated through the load, forced in either through the ice bunkers or through the car door. In the warehouse method the fruit is first cooled in the warehouse cooling rooms before being loaded into the car for shipment. Where the precooling is done after the cars are loaded, cooling can not be commenced until the car is fully loaded and transported to the precooling plant. This necessarily involves some delay before cooling, such delay, if considerable, corresponding in a way to the delayed cooling of fruit under ordinary refrigeration. In the warehouse type of plant the fruit can be placed in the cooling rooms as soon as it is packed, and the cooling accomplished with less delay. As a rule, the cooling is more uniform in a warehouse plant and less refrigeration is required than in car precooling, as there is less leakage through the walls of the storage house than in the case of an ordinary refrigerator car. The refrigeration in a warehouse can be secured either by the use of an ammonia plant or from a mixture of ice and salt. For small associations, especially where ice can be obtained at a reasonable price, ice and salt plants are both practical and probably more economical than the more expensive ammonia plants. In this system, refrigeration is secured by drawing the air through the bottom of an insulated tank filled with a mixture of ice and salt. The temperature of the air after it has passed through this mixture will depend upon the percentage of salt mixed with the ice. Air is forced through a false floor in the cooling room up through and between the boxes of fruit and is again taken back to the ice tanks through ducts in the ceiling of the cooling room. This type of plant is, as far as equipment is concerned, very inexpensive and is especially applicable to sections where the shipping season is relatively short and where the output is not large enough to justify a larger and more expensive ammonia plant. No engineer is required for its operation, as any man with ordinary common sense can operate it efficiently.

Whatever method of precooling is used, it is essential that the fruit be cooled as promptly as possible after removal from the tree and that the cooling be thorough. Any considerable delay in cooling or failure to cool thoroughly may nullify any benefit that would result if the precooling had been done promptly and thoroughly.

COLD STORAGE.

Neither oranges nor grapefruit are held in cold storage to any extent in the producing districts prior to shipment to the markets. Limited quantities of both oranges and grapefruit are, however, frequently placed in cold storage at the market end. The success with which sound fruit can be held in storage depends primarily on two factors, the

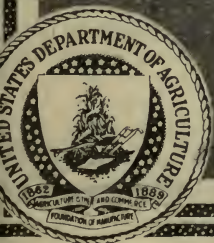
length of the time in storage and the temperature at which it is held. Oranges, grapefruit, and lemons should be stored at temperatures considerably above 32° F.; oranges at 38° to 40°, lemons at about 42°, and grapefruit at 45° to 50°. Even at these temperatures the period of successful storage is comparatively short, not usually exceeding two months and frequently not more than a month or six weeks. Oranges take on a sort of brown stain in storage, in addition to being just as susceptible to serious spotting due to attacks of *Colletotrichum* as are grapefruit and lemons. This spotting is much more severe at low temperatures, particularly 32° F. It almost invariably develops on oranges or grapefruit when held for any length of time at 32°, or even on fruit held at more favorable temperatures too long. Frequent inspection should be made of fruit in storage, in order that any showing signs of spotting may be immediately removed and disposed of.



Fud

U. S. DEPARTMENT OF
AGRICULTURE
FARMERS' BULLETIN No. 697

DUCK
RAISING



DUCK RAISING is conducted successfully both as a side issue on general farms and as a special business on a large scale. The Pekin is the best breed for duck farming. Many breeds are very ornamental as well as useful, making the breeding of real interest wherever there are natural facilities for keeping waterfowl.

The rearing of ducks for market on a large scale requires extensive capital and experience. Young ducks forced for rapid growth and marketed at from 8 to 12 weeks of age are called "green" ducks. They weigh from 4½ to 6 pounds each and are the principal source of income on commercial duck farms.

A location on a stream of running water is essential for the best results in duck farming.

The market for ducks is usually limited to the larger cities, and the demand is not nearly so general as the demand for chickens, while the market for ducks' eggs is even more limited.

Washington, D. C.

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DUCK RAISING

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NUMBERS OF DUCKS IN THE UNITED STATES

ACCORDING to the Federal census of 1920 there were 2,817,624 ducks in the United States on January 1 of that year, valued at \$3,373,966. No statistics on ducks were taken in the 1925 census. The 1920 census shows a slight decrease in numbers from the preceding census of 1910, indicating that the production of ducks in the country as a whole is not quite holding its own. The decrease occurred in the Southern States, but several of the States in which ducks are raised on special duck farms showed an increase in the number kept. California, Massachusetts, and Colorado showed an increase of 4, 7, and 12 per cent, respectively. New York, which contains by far the greatest number of commercial duck farms, showed no change in the number of ducks, but as the number raised on commercial farms undoubtedly increased materially during that period a decrease in the number on general farms must have occurred to offset this increase on duck farms.

Ducks are most numerous in the following States, arranged according to their production: Iowa, Illinois, Pennsylvania, New York, Missouri, Minnesota, Tennessee, Ohio, South Dakota, Indiana, and Nebraska, the number ranging from about 235,000 head in Iowa to 100,000 in Nebraska. There are about the same number of ducks as of geese in this country, and only about three-fourths as many ducks as turkeys. The number of ducks kept in proportion to the total population is much lower in the United States than in most other countries. The relative number in Great Britain, Ireland, and New Zealand is several times larger than in this country. The duck products in this country are consumed largely by the foreign-born population.

BREEDS OF DUCKS

There are 11 standard breeds of ducks which have been admitted to the American Standard of Perfection. These breeds may be divided into three classes: (1) The meat class, including the

Pekin, Aylesbury, Muscovy, Rouen, Cayuga, Buff, and Swedish; (2) the egg class, represented by the Runner; and (3) the ornamental class, composed of the Call, the Crested White, and the Black East India. Many farms in the South and the Middle West keep ducks of mixed breeding, which are generally small-sized, poor layers, and undesirable types of market duck. Except the Muscovy all our economic breeds of ducks are said to have originated from the wild Mallard.



FIG. 1.—Pekin drake

THE MEAT CLASS

THE PEKIN

The Pekin is almost the only breed kept by American commercial duck farmers who make a specialty of producing "green" ducks; it is also the most popular breed on general farms. Green ducks are ducklings which are grown rapidly and marketed at from 8 to 12 weeks of age, when they weigh about $4\frac{1}{2}$ to 6 pounds apiece. If not sold at that time the market quality of their flesh depreciates, their weight decreases, and it takes several weeks to get them back into good market condition.

The Pekin duck (fig. 1) originated in China and about 1873 was introduced into this country, where it soon became the most popular breed on commercial duck farms. With very few exceptions all the Pekins in this country are descended from about 20 ducks. The in-

troduction of the Pekin, which was soon followed by the use of artificial incubation, practically marks the beginning of intensive commercial duck farming in the United States. A duck of this breed has a creamy-white plumage, a long, broad, and deep body, with a full breast and deep keel (the part extending backward from the breast). The color of the skin is yellow, the shanks and toes should be reddish orange, and the bill orange yellow, free from black. Standard weights of the adult drake and duck are 9 and 8 pounds, respectively. The Pekin combines utility and beauty to a high degree, and the ducks kept on the commercial farms are very uniform. They are hardy, are fair layers, practically nonsitters, and are especially adapted for the production of flesh. They are timid and



FIG. 2.—Aylesbury drake

easily frightened, very docile, easily confined by low fences, and well adapted for either commercial duck farming or as a side issue on general farms.

THE AYLESBURY

The Aylesbury duck (fig. 2) is a native of England, in which country it is much more popular than the Pekin. It is a large, white duck having the same standard weights and general type as the Pekin, but its body carriage is nearly horizontal. This breed resembles the Pekin in many ways, but has never become popular in this country, although it was used before the introduction of the Pekin. The Aylesbury ducks kept in this country seem to be less hardy and vigorous than the Pekins, but are adapted for use on

either commercial duck farms or general farms. The breed has pure white plumage, whereas in the Pekin it is creamy white.

THE MUSCOVY

There are two standard varieties of Muscovy ducks, the white and the dark. This breed originated in South America and is thought to be a different species from the other ducks in the United States, although it may be crossed with domestic varieties of ducks, producing hybrids which are sometimes fertile. The head and face of the Muscovy (fig. 3) are partly bare, with red, rough, carunculated skin. It has a long, broad body, with greater breadth but less depth and less keel development than the Pekin. The drake should be at least one-third larger than the duck, as the standard weight of the



FIG. 3.—White Muscovy drake

adult drake is 10 pounds and that of the duck 7 pounds. The white variety has pure white plumage, pale orange or yellow legs, and a pinkish, flesh-colored beak. The breast, body, and back of the dark Muscovy are a lustrous blue black, broken with some white. The wing coverts are also a lustrous blue black with splashes of white, and the tail is black. The bill is pink, shaded with horn, and the legs may be yellow or a dark, leaden color.

Muscovy ducks are not well adapted for commercial duck farming, as they are only fair layers, and they are not well suited for marketing because of the difference in size of the duck and the drake. Moreover, they are good fliers and can readily fly over ordinary poultry fences. However, the breed is a wide forager, requires very little care, is not so noisy as the Pekin, and can be kept with fair success on general farms.

THE ROUEN

The Rouen duck (fig. 4) derives its name from the city of Rouen, in northern France, and was probably derived from a similar type of common or native duck by selection. In shape and type this breed is similar to the Pekin, and it has the same size and standard weights. The eyes are dark brown, and the head and upper part of the neck of the male are green, with a white ring around the neck, while the back is gray mixed with green near the neck, shading into a lustrous green near the tail. The lower part of the body is gray, and the breast is claret colored. The tail and wings are gray and brown,



FIG. 4.—Rouen duck

mixed with some green, while the wings have a wide, purple bar with narrow, white bars on each side of the purple, which are exposed when the wing is folded. The shanks and toes are an orange or orange-brown color. The duck is barred on the wings similarly to the drake, but the color of the plumage of her body is brown, with penciling in all sections. This breed has very handsome markings but does not make so desirable a market duck as the Pekin or Aylesbury, as it does not mature so quickly, and besides has dark-colored pinfeathers. It is not adapted to conditions of commercial duck farming, but is suitable for use by the fancier or by the general farmer.

THE CAYUGA

The Cayuga duck derives its name from Cayuga County, N. Y., where it probably was developed about 1850. It resembles the Pekin in shape, but the standard weight is 1 pound lighter. The Cayuga is a good market duck, but it is not widely distributed, and, because of its dark plumage, it is not so good a market duck as the Pekin. The Cayuga duck is a fair layer and may be raised with success on general farms. The plumage is a greenish black in all sections of the body, except that the drake may have brown flight feathers; the eyes are dark brown; and the shanks and toes are black or dark slate color.

THE BUFF

The Buff duck, more commonly called the Buff Orpington, originated in England and was not admitted to the American Standard of Perfection until 1915. It is said to have been produced by crossing the Runner, Aylesbury, Rouen, and Cayuga. Standard weights are 1 pound lighter in each class than the Pekin. It has been developed in England for the production of eggs and is a good producer, and also makes a fair market or table duck. The breed has not been bred much in this country but has qualities which would make it a good duck to keep on general farms for both eggs and meat production if it were improved. The Buff has good length of body, which is broad, deep, and well rounded. The plumage is an even shade of rich, fawn buff, except the head and the upper portion of the neck in the drake, which should be seal brown.

THE BLUE SWEDISH

The Blue Swedish duck probably originated in Germany, although blue ducks are found in several other European countries. The breed resembles the Pekin in type, but is smaller, with the same standard weights as the Cayuga, except that both the young drake and the young duck are one-half pound lighter than in that breed. The plumage of the Blue Swedish is blue in all sections, except that it has a white bib on the neck and the two main flight feathers are pure white. This breed is not widely distributed in this country and is not so well adapted for commercial purposes as a white duck; however, it is a fair variety for use on general farms.

THE EGG-LAYING CLASS

THE RUNNER

The Runner, commonly called the Indian Runner, received its name from its supposed introduction from East India, but the evidence appears to show that it is a selected type of a duck which was common in Belgium and Holland. There are three standard varieties of Runner ducks—the Fawn and White, the White, and the Penciled. The Fawn and White is fawn or gray and white, with a white neck and a line of white running up to the eyes and extending around the bill. The back and shoulders are fawn, and the

upper part of the breast and wings are fawn, but the lower part is white. The breast is full; the body is long and narrow, sloping gradually into the neck, and is carried erect, with no indication of a keel, the body resembling somewhat that of a penguin in shape. The shanks and toes are orange-red, and the bill of the young drake is yellow, later becoming greenish-yellow, while a young duck has a yellow bill spotted with green, which later becomes a dull green.

The plumage of the White variety (fig. 5) is pure white in all sections. The bill is yellow and the shanks and toes are orange. The color of the Penciled variety (fig. 6) resembles that of the Fawn and White except that the head of the male is a dull, bronze-green



FIG. 5.—White Runner drake

and white and the back has a soft, fawn ground, finely stippled with a slightly darker shade of fawn. The body and the upper section of the breast are medium fawn and the tail is a dull, bronze-green. The head of the female is a medium fawn and white, while the white markings in the plumage resemble those of the male. The colored markings are a medium fawn throughout, with a light line of fawn color running around the edge of each feather, the border being a darker shade.

The Runner duck is much smaller than breeds of the meat type, the adult drake having a standard weight of $4\frac{1}{2}$ pounds and the duck 4 pounds. A few years ago the merits of this breed were advertised

extensively, and the number of Indian Runner ducks increased rapidly for a few years, but this greater rate of increase did not last. They are among the best layers of all the American standard breeds of ducks and hold the same relative position in the duck family that the Leghorn does among the breeds of domestic fowl. This breed lays a good-sized white egg considerably larger than a hen's egg. Runner ducks are active, are good foragers, nonsitters, and hardy. Their skin is yellow, and they make fair broilers, weighing from 2½ to 3 pounds each at about 6 weeks of age. They are not adapted for the production of large green ducks, but may be kept to produce ducklings of broiler size. The Runner ducks have made excellent records in the egg-laying contests, both in this country and abroad.



FIG. 6.—Penciled Runner drake

The Runner is a good breed for the general farmer and is one of the best for the production of market eggs. Opportunities to keep ducks for the production of eggs for market appear to be rather limited in this country.

Runner, Buff, and Khaki-Campbell ducks have proved to be good egg producers. The Khaki-Campbell is not included in the American Standard of Perfection. These ducks will produce well for three or four years, and the record the second year is often as high as the first year. If the production of duck eggs for market is considered, special attention should be given to procuring ducks which have been bred for egg production. The business of the production of duck eggs for market is discussed in the latter part of this bulletin, under "Marketing ducks' eggs."

THE ORNAMENTAL CLASS

THE CALL

There are two varieties of Call ducks, the Gray and the White. They are the bantams of the duck family, are kept for exhibition or for fancy purposes and are used as decoys in wild-duck shooting. This breed is said to be especially good for decoys when crossed with the wild Mallard or with the common duck. The Gray Call has the color markings of the Rouen and closely resembles the wild Mallard. The plumage of the White Call is pure white. Ducks of this breed have no standard weights, but are bred and selected for small size.



FIG. 7.—Crested White drake

THE CRESTED WHITE

The Crested White is a white ornamental duck of medium size and has a crest. (Fig. 7.) The standard weights are a pound less than those of the Cayuga duck.

THE BLACK EAST INDIA

The Black East India duck is of practically the same size and type as the Call duck and is kept entirely for ornamental purposes. The plumage is a deep black, with a brilliant, greenish tint. This duck is very shy and does not breed well in confinement. Crested White and the Black East India ducks are somewhat rare in this country.

THE MANDARIN AND THE WOOD

The Mandarin and the Wood, or Carolina ducks, which are the most ornamental of the small breeds of waterfowl, are not included

in the American Standard of Perfection. The plumage of these breeds is handsomely marked and contains several brilliant colors. Both varieties are commonly kept in parks and zoological gardens with other ornamental waterfowl.

DUCK FARMING

Duck raising on a large scale has been developed as a special business to a considerable extent on Long Island (fig. 8) and in sections within easy shipping distance of New York City, Boston, and Philadelphia. A location with either good railroad or good truck shipping facilities to a near-by large city where ducks are in demand is essential for a large duck farm. Large flocks of ducks are very noisy, and require a somewhat isolated location. Intensive duck farming on a large scale has been more successful than intensive chicken raising, as Pekin ducks, especially, stand confinement well,



FIG. 8.—Large duck farm on Long Island

are more easily brooded, and are less subject to disease than chickens. Artificial methods of hatching and rearing and labor-saving machinery have been used very successfully on duck farms.

The demand for table ducks at good prices is mostly limited to a few large cities and is not nearly so general as the demand for chickens or fowls. The demand, however, appears to be gradually increasing, but the lack of a wide market materially influences the establishment and growth of duck farms. It would be possible to build up sufficient trade in most of the larger cities, especially in those containing a considerable percentage of foreign-born population, to take the product of one good-sized duck farm. The market conditions should be studied carefully before a large investment in ducks is made. The rearing of ducks for market on a large scale is a business requiring capital and extensive experience. Practical experience on a large duck plant is the best teacher, but the novice should begin in a small way and enlarge as experience justifies.

Ducks can be raised with success and at a profit on general farms, but are not so well adapted as fowls to supply a source of income under average farm conditions, although they serve to add variety of both meat and eggs for the farmer's table. Breeds of ducks which are of good, marketable, table quality and also are fair egg producers are best suited for use on general farms and may be kept profitably wherever good pasture land with running water is available. The Pekin, Rouen, and Cayuga are the best breeds for this purpose, while the egg breeds, such as the Runner, may be a profitable breed to keep on many farms. Their house should be near the water, and the site should be fenced sufficiently to keep livestock away. Farmers rarely give the necessary care to their ducklings in either feeding or marketing to be able to cater to the trade in fancy green ducks.



FIG. 9.—Duck yards extending into water

SITUATION AND ARRANGEMENT

The most desirable situation for a duck farm is on a light sandy soil with a gentle southern slope, leading to a stream, as shown in Figure 9, so that the pens for the breeders can be extended 25 feet or more into running water, as the fertility of the eggs is better, as a rule, if the ducks have access to water. A natural supply of water is almost essential for commercial duck farming and lessens the labor. The arrangement of the buildings should be planned to economize labor and allow for increase of the equipment. The necessary buildings consist of breeding pens, an incubator cellar, brooder houses, fattening sheds, and places for storing and mixing feed and for killing and picking the ducks. The pens in the houses, the outside yards, and the arrangement of the buildings should be planned

so that the ducks may be easily driven from house to house. The feed room or house should be centrally located.

Considerable machinery for mixing feed is used on all large duck farms, and most of these farms have tracks for feed trucks, pushed by hand, to facilitate the moving of feed to the different houses and yards. Convenient watering arrangements are essential where large numbers of ducks are kept, as ducks require a large quantity of drinking water. Plenty of shade should be provided for all the ducks. Although they may be kept successfully under very intensive conditions, it is advisable to allow considerable yard space. Double yards, which may be rotated and planted to quick-growing crops, such as oats, wheat, and rye, are good for intensive duck farms.

Most of the Long Island duck farms have sandy yards which are cleansed by the rise and fall of the tide. All duck yards should be made on gently sloping land. The yards must be kept clean, which



FIG. 10.—Flock of breeding ducks and breeding house

may require scraping off the top surface in some yards. Sufficient land should be available to raise green feed and to utilize the manure produced. Ducks for market should be allowed to go into the water after they are 6 weeks old, as it saves much labor in watering and greatly improves their feathers for market. Ducklings under 6 weeks should not be allowed to go into water.

HOUSES

The site of the poultry house must be dry, well drained, and raised above the general level of the land. A light, porous soil makes the best location. A shed-roof breeding house 24 feet deep and 48 feet long, 8½ feet high in front and 5 feet in the rear, makes a good house and will hold two flocks consisting of 50 breeders in each, as it is best to allow approximately 10 square feet of floor space for each breeding duck. (Fig. 10.) Breeders are usually kept in flocks of from 30 to 60, but in some cases as many as 100 duck breeders are

kept in one flock. About half of the front of the building should be of glass windows and space for muslin curtains, in equal proportions. A glass window on the east and one on the west end help to ventilate and dry out the house during mild days. The walls, except on the north side, may be of barn boards 12 inches wide, with the cracks left open for ventilation. Ventilation is of vital importance, as the comfort and health of the ducks depend upon an abundant supply of pure, dry air. The roof should be water-tight. A dirt floor which is from 4 to 6 inches above the ground level is satisfactory on light, well-drained soil. Board floors, raised 6 or 8 inches above the ground and covered with 4 inches of sand or dry earth may be used.

The breeding pens should be bedded down with additional straw or shavings whenever the litter gets wet and soiled. The litter is allowed to accumulate and is cleaned out only twice a year. It helps to keep the ducks comfortable during the winter but makes good ventilation absolutely necessary. During the day, except in stormy and cold weather, all the windows should be opened wide to allow the bedding to dry. Nests are usually provided, made like stalls, 12 inches wide, 18 inches deep, boards about 12 inches high being used to separate the nests. These 12-inch partition boards are nailed to a strip about 5 inches high, which forms the front of the nest, making a row of nests when placed against the back or side of a building. Some duck breeders do not provide nests but allow the ducks to lay on the floor. The yards should be about 100 feet long and the width of the pen, and extend 30 feet into the stream if possible. Poultry wire about 2 feet high will keep mature ducks in their respective yards, and 18-inch high wire will hold ducklings.

BROODER HOUSES

Long brooder houses heated by hot-water-pipe systems are used where ducks are raised on a large scale, as shown in Figure 11. A single brooder house should face the south, and double brooder houses should face east and west. There should be a large glass window for each pen in the brooder, as plenty of light is desirable. The window should be arranged so that it can be easily opened to allow direct sunlight in each pen. A shed-roof house, about 12 feet deep, 6½ feet high in front, 4½ feet in the rear, and as long as desired, makes a good building for a single brooder house. (Fig. 11.)

A double brooder house should have a gable roof with sides about 5 feet high and ridge 8 feet high. The hot-water pipes run through the center of the building, four on each side of the dividing pen partition which runs through the center of the house. Over these pipes is a platform under which the ducks hover, and it is also used by the attendant as a walk. (Fig. 12.) No cloth cover is used in front of the pipes except in severe weather, when a burlap bag may be hung there. This double house is 20 feet wide, and each pen is divided into sections 4 feet wide and 10 feet long, including run under the pipe. Each section will take care of 100 baby ducklings. Each partition should be about 1 foot high and so arranged that part of the partition in each pen can be removed in order to drive the ducks from one pen to the other, as the heating pipes are nearer the floor in one end of the



FIG. 11.—Brooder house for raising young ducks on a large scale



FIG. 12.—Interior of duck brooder house, showing feeding pans in center. Hot-water pipes and hover are in the center of the house, under board walk

house and gradually rise toward the farther end of the building, to take care of the ducklings of different ages. The smallest ducklings are kept where the pipes are nearest to the floor, or about 3 inches above their heads, and as they grow they are moved to pens where the pipes are higher; less heat is needed as they develop.

A second gable-roof brooder house about 20 feet deep is used with pipes placed much higher from the floor of the pen in order to accustom the ducks to less heat before they are transferred to a cold brooder house. These pens in the second brooder are about 10 by 15 feet, accommodating about 200 ducklings when 3 or 4 weeks old. A third or cold brooder house is not heated, and may be a shed-roof house about 18 feet deep, 4½ feet high in the rear, and 7 feet in front. Large, cold brooder houses, up to 30 feet in width, are sometimes used in place of the narrow houses.



FIG. 13.—Breeding flock of Pekin ducks

Good judgment must be used when transferring ducklings from a second heated brooder house to a cold one, as early hatched ducklings require heat much longer than late-hatched ducklings. They are transferred from the cold brooder to the fattening pens along the water front when the feathers are partly grown on their backs, as after that age they do not require shelter, except shade from the hot sun.

SELECTING AND MATING

The selection of vigorous breeding ducks is very essential to successful duck farming. The breeders are selected about July 1 from the young ducks that are almost ready for market at that time. Only the most vigorous and best-developed ducks are saved for breeding. (Fig. 13.) These ducks are kept only during their first

laying season and are then marketed. Older ducks do not lay eggs enough during the early part of the winter to produce sufficient numbers of market ducks, but it may pay to keep a few, out of which to get the breeding stock.

In handling ducks pick them up by their necks rather than by the legs, as the latter are apt to break easily. Ducks lay their eggs early in the morning and should be confined to the house or pen until 9.30 a. m. If allowed to roam early in the morning they may lay in a pond or stream and the eggs may be lost. The average Pekin duck lays from 100 to 120 eggs each season. These ducks are kept only for the production of good hatching eggs and are fed so that they will begin to lay in November or December. The drake is usually coarser and more masculine in appearance than the duck and has a distinct curl in his tail feathers. During the cold weather 5 ducks may be mated to 1 drake, about April 1, 6 to 1 is sufficient, and later, about June 1, 7 or 8 ducks to 1 drake. On large duck farms ducks are sometimes mated in pens of 100 or more. Three hundred breeders will produce market ducks enough for a one-man duck farm.

INCUBATION

The period of incubation for ducks' eggs is 28 days, except for the Muscovy duck, which is 33 to 35 days. The eggs may be hatched either naturally or artificially, but on practically all the large duck farms the hatching is done in incubators. Incubators should be operated in a well-ventilated room or cellar, which is about two-thirds below the ground level, so that the temperature remains fairly even. The cellar should be from $7\frac{1}{2}$ to $8\frac{1}{2}$ feet high, with plenty of windows above the ground level for light and ventilation. Large incubators with automatic devices for turning the eggs are used on almost all the duck farms. Strong, fertile eggs are a prime essential to good hatching and are obtained only from stock properly mated and kept under the best possible conditions for health and vigor.

Pekin and Runner ducks rarely sit; consequently, if natural methods of incubation are to be used, the eggs are usually hatched under hens. Ducks' eggs should be washed as collected if dirty, as washing does not appear to injure their hatching qualities. Hens must be well cared for in hatching ducks' eggs, as the period of incubation is a week longer than that of hens' eggs. It takes ducklings usually from 24 to 48 hours to hatch after they pick the shells; therefore it is advisable to allow the hen to get off the nest for feed and water when the first ducklings pick the shell and then confine her to the nest until after the hatching is over. Ducks' eggs need more moisture than hens' eggs at hatching time, as it takes the ducks much longer to get out of the shells. The eggs, therefore, should be sprinkled with warm water just before they are ready to pip.

The incubators should be perfectly level and should be operated for a few days before the eggs are put in. The thermometer should be arranged so that the bulb just clears the top of the eggs; with the bulb in this position the temperature should be $102\frac{1}{2}^{\circ}$ F. for the first week, 103° from then until time of hatching, when it may be allowed to reach $103\frac{1}{2}^{\circ}$.

Incubators planned for hatching duck eggs may be obtained from the incubator manufacturers, but when only a few eggs are to be hatched the regular hen-egg machine may be used. Follow the manufacturers' directions in operating the incubator. The eggs are usually turned twice a day from the third to the twenty-fifth day, inclusive, but if the incubator has an automatic turning device, it pays to turn the eggs at least three times daily. The eggs may be cooled from the tenth to the twenty-fourth day, inclusive, but the practice of cooling eggs is not so general as it has been. Cooling should be regulated according to the room temperature.

It is usually advisable to supply moisture for duck eggs after the tenth day of incubation, but this depends on the make of the incubator, on the climate, and especially on the humidity of the place where the incubator is operated. Many methods are used to supply moisture in incubation, such as sprinkling the eggs with warm water heated to about 100° F., or placing below the egg tray a pan of water, a receptacle containing moist sand, or a wet sponge. Other common methods of supplying moisture are to sprinkle or soak the floor of the incubator room or to place a pail of warm water under the lamp.

Eggs which have become overheated can be cooled quickly by sprinkling with cold water. Shut the incubator tightly when the ducklings begin to pip, close the ventilators, and do not open the machine until the hatching is over. If the tray is too crowded with ducklings, ventilators may be opened when the hatch is two-thirds off, but the doors should not be opened under any circumstances. When all the ducklings are hatched, remove the egg tray, open the ventilators, and keep the incubator door open slightly. Allow the ducklings to remain in the incubator from 24 to 36 hours at a temperature of 90° F. without feeding. In taking the ducklings to the brooder house, keep them well covered to guard against chilling.

TESTING EGGS

All eggs are tested two or three times during incubation, and the infertile eggs and those with dead germs are removed. Dead germs in duck eggs decompose very rapidly and are often detected by their odor. Such eggs should be removed from the incubator. Infertile eggs, when boiled hard, make good feed for ducklings. Infertile eggs are often used for culinary purposes or sold to bakers. The first test is usually made on the fifth or sixth day and the eggs are tested with the large end up, so that the size of the air cell may be seen, as well as the condition of the embryo.

Testing should be done in a dark room. The infertile egg when held before the tester looks perfectly clear, much the same as a fresh egg, whereas a fertile egg shows a small, dark spot—the embryo—with a network of small blood veins extending in all directions if the embryo is living, but if it is dead the blood settles away from the embryo toward the edge of the yolk, forming in most cases an irregular circle of blood, known as a blood ring. The eggs containing strong, living embryos are dark and partly filled by the twenty-first day, and show a clear, distinct line of demarcation between the air cell and the growing embryo, whereas dead germs show only partial development and lack this clear, distinct outline.

BROODING

Ducks are much easier to brood artificially than chickens, and artificial methods are used entirely on duck farms. The ducklings are removed from the incubator from 24 to 36 hours after hatching taken to the brooder house (fig. 12), and then given their first feed. About 100 ducklings are placed in a pen 4 by 10 feet. A board across the pen allows the ducklings to wander only 3 feet from brooder pipes during the first three days. If ducklings are raised under hens, it is advisable to confine the hens and allow the ducklings free range, as the hens are apt to wander too far with their broods.

The temperature under the hover should be 95° F. for the first week, 85° the second week, and about 80° for the third week until they are removed to the second brooder house, where the temperature under the hover is kept at from 70 to 75°. From the second brooder house they are driven to the cold brooder house without heat when 6 weeks old—a little earlier in the warmer months and a little later in the colder months. The temperature at which to keep the hover depends on the section of the country and the weather conditions. Lights are commonly used all night in the pens of ducklings, to keep them more contented. This also increases feed consumption. Shade in the yards is essential for ducklings during warm weather. This is usually provided by the use of artificial shelters. About four weeks before marketing, the ducks are transferred to the fattening yards, which preferably extend into the water about 50 feet. Lights are also used in the fattening pens. About 300 ducks are placed in each yard, which is about 100 by 150 feet. Here they have a chance to swim and clean their plumage in the water until ready for market.

METHODS OF FEEDING

The ducks to be used for breeders are separated about July 1 from the growing ducks and fed a bulky mash containing very little meat. The object in feeding these ducks is to develop breeders which will produce the best hatching eggs. All duck rations are fed as a moist mash and are usually mixed in dough mixers or good-sized mixing machines. A good breeding mash may be made of 10 parts, by weight, bran, 5 parts middlings, 5 parts yellow corn meal, and one-third part meat scrap or fish meal. This mash is mixed with green feed, from one-third to one-half as much green feed as mash, by bulk being used. The meat scrap or fish meals is gradually increased, beginning about October 1, to about 12 per cent of the grain by October 15, which is the maximum quantity desirable in a laying ration for breeders. At this time the corn meal is also increased making the mash consist of 10 parts, by weight, bran, 5 parts middlings, 15 parts yellow corn meal, and 4 parts meat scrap or fish meal. All duck rations are mixed with green feed. Another good ration for egg production for breeding ducks consists of the following, the proportions being by weight: 1 part bran, one-half part middlings, one-half part low-grade flour, 2 parts yellow corn meal, one-half part meat scrap, and one-fourth part cooked fish or one-eighth part fish meal, mixed with green feed. The breeding duck

should be fed twice daily—in the morning and at night. A light feed of equal parts whole corn and oats is sometimes used with these mashers for laying ducks. Green feed consists of creek grass, clover, young corn, rye, cowpeas, or any other available green feed, cut up by machine in about $\frac{1}{2}$ -inch lengths and mixed in the feed. Ground alfalfa may be used if no green feed is available, about 15 per cent being used in the mash. Cooked vegetables at the rate of one-fifth of the mash may also be used if no green feed is available. Rye is the first green feed in the spring, followed by oats, and then fodder corn in the summer. In August rape is sown and is available until freezing weather.

Breeding ducks are given all they will eat. The feed should be wet enough to hold together when squeezed, somewhere between sticky and crumbly, but it must not be crumbly. It is not advisable to feed fresh fish entirely and no meat scrap, as fresh fish is not always available, and changing the ration is likely to cut down the egg yield. Oyster shell and sand should always be kept before the breeding or laying ducks. Breeding ducks which are laying should be shut in the house in the evening and not released until about 9.30 a. m., so that they will lay their eggs in the house. The meat scrap in these laying rations may be increased to about 15 per cent, and the quantity of green feed reduced for the production of market eggs in feeding the Runner or egg breeds. Such breeds are fed laying rations throughout the year. Other good rations for laying ducks fed for market eggs may be made of a mash of 3 parts middlings, 1 part corn meal, 1 part ground oats, 2 parts bran, and 1 part fish or meat meal. This is fed with a grain mixture of 3 parts wheat and 1 part corn. A good ration may be made of mash alone by using 4 parts middlings, 2 parts corn meal, 2 parts ground oats, 1 part bran, and $1\frac{1}{2}$ parts meat or fish meal.

Ducklings should not be fed until about 48 hours after they are hatched. For the first five days in the brooder house, feed a moist mash of 2 parts, by weight, bran, 1 part yellow corn meal, and one-half part low-grade flour or middlings, to every 100 pounds of which add 10 pounds of ground oat groats or rolled oats, 3 pounds of sifted meat scrap or fish meal, and 3 pounds of sifted sand. It is advisable to mix this mash with milk. Eggs are an excellent feed to use in place of the meat scrap for this first feed, using two infertile incubator eggs, hard boiled, to every quart of feed. The ducklings are usually fed five times daily until 5 days old, four times daily from the fifth day until they are 4 weeks old, and three times daily until marketed. Sand or grit is kept before them all the time. When the ducklings are 5 days old the eggs and milk are omitted from the ration, and 5 pounds of meat scrap is included in 100 pounds of mash. At 2 weeks of age the meat scrap is increased to 10 pounds per 100 and at 4 weeks to 15 pounds per 100. Increase the corn meal to 2 parts at the fifth or sixth week and add about 10 per cent by bulk of green feed to the ration.

Ducklings should be allowed to range only about $2\frac{1}{2}$ feet from the hover for the first three or four days, until they learn to run under the hover for heat. The pens should be bedded with straw or shavings. Water should be given them at each feeding time in protected fountains, arranged so as not to wet the straw or bedding.

Brooder-house pens should be cleaned out about every 10 days and fresh straw added. During the winter months, after the ducks are 10 days to 2 weeks old, they are usually allowed out of the brooder house whenever the weather is good. If it is necessary to confine the ducklings to the house all or most of the time, 2 per cent of cod-liver oil should be added to the mash. If little direct sunlight is available during the winter months, it probably would be advisable to use the cod-liver oil. It should be omitted from the ration for at least two weeks before the ducks are marketed, as it may affect the flavor of the flesh.

When the ducks are well feathered, at from 7 to 8 weeks of age (fig. 14), they are moved to the water front and fed a fattening mash, until marketed, of 3 parts (by weight) corn meal, 1 part bran, 1 part meat scrap, 1 part low-grade flour or middlings, and one-half



FIG. 14.—Pekin ducks about 7 weeks old in fattening pen

part green feed. Feed troughs should be kept near the water in the fattening pens to reduce exercise. Fresh fish, if used, should be left out of the ration for market ducks four weeks before they are to be killed, so that no fishy flavor may be given to the flesh. Feed should not be left before the ducks and allowed to sour, as it is apt to cause convulsions and death, especially among young ducklings. Ducklings and ducks are usually fed mash on flat feed boards rather than in troughs. Plenty of drinking water is very essential and should be near the feed, so that the ducks can eat and drink at about the same time. Water fountains should be deep enough to allow the ducks to get their bills into the water to wash sand or grit out of their nostrils. Green ducks are usually marketed when 10 weeks old, but the marketing age varies from 8 to 12 weeks of age, according to their condition, weight, and the season of the year. In the

New York market preference is given to ducks weighing about $5\frac{1}{2}$ pounds each. Buttermilk, either concentrated or dried, is being used in the feeding and fattening of ducks.

The loss in rearing ducklings under good conditions is usually from about 8 to 10 per cent, and both ducklings and breeding ducks are comparatively free from diseases if properly managed. The losses in growing ducks usually occur before the ducklings are 1 month old. Ducks are affected by the same diseases as chickens, and similar methods of treatment are used.

PREPARING DUCKS FOR MARKET

Most ducks are sent to the city markets dressed, but some markets, especially New York City, handle a large number of live ducks. Green ducks should not be held after the long wing feathers have reached their full length, as the ducks reach their best condition at that time. The ducks are usually hung up by their feet in a row,



FIG. 15.—Open-shed shelter for fattening ducks

and the jugular vein in the throat just below the base of the skull is cut through the mouth. As soon as the cut has been made the duck is stunned either by a hard blow on the head or by plunging the point of a knife into the brain through the roof of the mouth. A blood can or a weight is hooked through the mouth, and the feathers are plucked. If the ducks are to be scalded they are allowed to hang until thoroughly bled. The blood is saved and mixed in the mash for the growing ducks. The ducks are usually scalded for the New York market but dry-picked ducks are preferred in some cities. The water for scalding should be just below boiling, as too hot water discolors the flesh; the ducks should be scalded just as soon as they are through bleeding. The long tail feathers are left on the ducks, the wings are picked to the first joint and the neck halfway to the head. Long pinfeathers usually are removed with a dull knife, and the down is rubbed off with the moistened hand or shaved with a very sharp knife. Large duck farms usually have pickers who devote their time entirely to the dressing of ducks during the

marketing season and are very proficient in the work. The average duck picker can pick from 50 to 70 ducks in a day.

After the ducks are picked they are usually washed and put into ice or cold water to cool and "plump." They are packed in barrels and sent to market either with or without ice, depending on the weather and the distance from market. For ice packing each layer of ducks, usually with the keels or breasts down, is packed flat in barrels. A layer of crushed ice is placed on the bottom of the barrel on which is put a layer of dressed ducks, and alternate layers of ducks and ice are added until the barrel is nearly full; then the barrel is filled with a layer or header of ice. Boxes holding dry packed ducks are also used in some sections. These dressed ducks should be graded according to their size and thoroughly chilled before they are packed in barrels or boxes. It costs about 7 cents apiece to pick ducks, but the feathers pay for the picking. Each duck yields about 2 ounces of marketable feathers. The feathers must be dried by spreading them out in thin layers in a loft, and they should be turned several times until they are thoroughly dried. Then they are sold to feather dealers and are shipped in large, burlap sacks.

Green ducks are marketed throughout the year. In 1927 dressed ducks brought from 34 cents a pound in January to 24 cents in July on the New York market when sold at wholesale. The highest prices are paid for the ducks marketed in March and April, and they decrease as the season advances and the supply becomes more abundant. When prices in the spring and summer are low many of the ducks are put into cold storage and held for higher prices. During part of the year the New York market prices for live ducks equal or exceeded those paid for dressed ducks. Managers of large duck farms figure on marketing 50 ducks for each breeder. The demand for green ducks has been built up in large cities in the East and on the Pacific coast, and there is very little demand for them in small cities and towns. In recent years several inns specializing in duck dinners have been successfully operated in New York State and in Massachusetts. Ducks produced on general farms are not marketed until fall and bring lower prices than green ones.

MARKETING DUCKS' EGGS

The demand for ducks' eggs at a good price is limited and is nearly so general as the demand for hens' eggs. There is a good demand for ducks' eggs in the spring in New York and other cities at prices usually several cents a dozen higher than hens' eggs, but during the rest of the year ducks' eggs do not bring any higher prices than hens' eggs, although they are about one-fourth larger. The best grades of ducks' eggs sold in New York City for 58 cents a dozen the last of March, 1927. In April the sale price was about 4 cents, 36 cents in May, and 37 cents in June. A trade is gradually being established in some markets for fancy near-by ducks' eggs but the demand is very limited. Pure white eggs are preferred and usually bring the highest price. These eggs should be marketed frequently, as they depreciate in quality more rapidly than hens' eggs, especially during hot weather. The market for eggs should be carefully investigated by those who intend to raise breeds of the egg-laying type of ducks.



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TRENCHING MACHINERY USED FOR THE CON- STRUCTION OF TRENCHES FOR TILE DRAINS.

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INTRODUCTION.

The invention of suitable appliances for tile trenching has been stimulated by three agencies—the rising prices of labor, the rapid extension of tile drainage for farm lands, and the growing practice of using large tile instead of open ditches of moderate size for community outlets, especially where the depth of cut is rather great. Where wide trenches are dug by hand deeper than 6 or 7 feet, the material must be handled at least twice, since the dirt can not be thrown back from the edge of the trench at the first handling. Besides reducing the amount and cost of labor, a good machine greatly lessens the time necessary for doing the work, which is often of considerable advantage, apart from any saving in direct money cost. Difficulties such

NOTE.—This bulletin describes the types of trenching machines, and discusses the limiting conditions of work and the cost of trenching. It is based upon extended investigations by the writer, supplemented by data secured from manufacturers and contractors and from other drainage engineers. It will be of service to those whose lands need tile drainage. It does not deal with drainage of irrigated lands, where the requirements for good trenching machines are often unusual and the cost of work much greater.

as occasionally arise where many unskilled workmen are employed may be largely avoided by the use of machinery requiring only a small crew. The many types of equipment for trenching vary from special plows and scoops of ordinary size to elaborate machines costing thousands of dollars. The smaller kinds are limited in depth and width of trench, also in regard to conditions of working. Some variations from the machines described have been manufactured and not found practical; new designs that may be available in the future perhaps will be as good or better than those now on the market.

REQUISITES OF A GOOD MACHINE.

Three things are required of a good trenching machine, namely, (1) it must operate efficiently through various kinds of soil; (2) it must be capable of cutting true to grade; (3) it must work for long periods without breaking or otherwise getting out of order. The first of these requirements is the hardest to fulfill, the second is the easiest.

There are many kinds of soil to be encountered—hard shale, cemented gravel, sand, stones, loose loam, soft muck, and sticky clay. None of the machines will handle solid rock. The ideal machine will handle all kinds of soil, with but minor changes of parts, without breaking or stopping and at a minimum expense for purchase, operation, repairs, and depreciation. Open or skeleton excavating buckets are best suited to sticky soils, while solid buckets are necessary in loose dry soils, though some machines have efficient cleaning devices that permit the use of solid buckets for any kind of material. A machine must be strong to work through shale or stony ground, but if increased strength entails added weight, the efficiency and adaptability may be affected. A heavy machine can not work over soft ground unless fitted with rather costly apron tractors instead of the driving wheels. (See fig. 7.)

GENERAL CLASSES OF TRENCHING MACHINES.

The many types of trenching machines may be divided in four general classes: (1) Plows and scoops, (2) wheel excavators, (3) endless-chain excavators, (4) scraper excavators. The general nature of the plows and scoops is indicated by these names; they are usually operated by horses, and some merely loosen the dirt to make hand shoveling easier. In the wheel excavators the excavating buckets are arranged upon the rim of a wheel. (See fig. 6.) In the endless-chain excavators the excavating buckets are carried on parallel endless chains supported by a long steel frame at the rear of the machine. One end of the frame is lowered so that the buckets are drawn up the end of the trench, cutting a thin slice of earth from the bottom to the top. (See fig. 10.) The scraper machines are the same as the dipper

and drag-line machines designed for wide ditches, sometimes with slight changes in the rigging to give better control of the bucket. The largest machines of the third and fourth classes are adapted to deeper and wider trenching than are those of the other classes.

In the following descriptions of the various types, the letters used to designate the machines have been assigned arbitrarily by the writer for convenient reference.

PLOWS AND SCOOPS.

This class of excavators has been made to include the smaller and less expensive implements, which will be found economical for smaller jobs than would warrant the purchase of the more costly machines. Almost all the plows and scoops are lacking in any device for cutting accurately to grade. Some handwork is necessary to make the trench smooth for laying the tile properly. Many are limited in depth of digging to $2\frac{1}{2}$ or 3 feet, which is not as deep as tile should be laid in many places. Many of these implements are merely aids to hand work, using animal power only to loosen the dirt. The main advantage over the more elaborate trenching machines is their low cost. (See Farmers' Bulletin, No. 524, for information on digging trenches for small fields entailing hand work.)

DITCHING PLOW A.

Perhaps one of the simplest trenching devices is the ditching plow shown in figure 1, which is used only to loosen the dirt in order that shoveling may be easier. The U-shaped knife does most of the cutting; the side knives just behind keep the sides of the trench vertical. Each plowing cuts about 3 to 6 inches deep. The usual width of the trench is about 12 inches, but the side knives may be spread to cut 16 inches wide. This plow weighs about 165 pounds and costs about \$20. Two horses and two men are used with it.

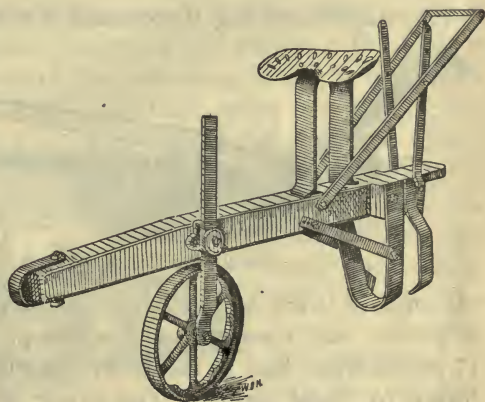


FIG. 1.—Ditching plow A.

DITCHING PLOW B.

Figure 2 shows another ditching plow for merely loosening the soil. The first furrow along the trench is made with an ordinary plow, then the ditching implement is used. This plow has no moldboard,

and the share cuts 6 inches wide on the bottom. An adjustable slider in front of the plowpoint regulates the depth of each cutting. The plow beam is adjustable vertically, being pivoted on the front arm of the standard and held in the desired position by a segment at the rear end of the beam. The first round of this plow cuts the sides of the trench straight down. The loose earth is then shoveled out, the plow beam is raised, and another round is made; this process is repeated until the desired depth is reached. The minimum width of trench is 8 inches, and the plow works in this width to 3 feet depth without difficulty. Wider trenches can be cut deeper, though it may be necessary to lengthen the distance between the plow and the team. An attachment is made for cutting a smooth groove in the bottom of the trench, in which to lay the tile, but there is no way of cutting to grade with this implement. The plow weighs about 150 pounds and costs about \$18. One man is required to drive the horses and one to handle the plow.

DITCHING SCOOP C.

This implement (fig. 3) consists of a knife or plow working similarly



FIG. 2.—Ditching plow B.

to plow A, and a bucket by which the loosened earth is removed from the trench. The heavy U-shaped steel cutter is mounted on a steel frame, and to

the ends of it are bolted trimmers for widening the trench sufficiently to permit easy operation of the scoop. The bucket is $3\frac{1}{2}$ feet long, 17 inches high, and 10 inches in top width. It is hinged to the cutter frame by steel straps. The lower end of the wooden handle is fastened to a loop near the bottom of the bucket. A hook on it engages the top of the bucket between guides that keep the bucket from tipping when the handle is upright.

Two men and a team are required to operate this scoop, which is filled by being drawn up the sloping end of the completed part of the trench. The depth of each cutting is controlled by an adjustable shoe just in front of the cutting knife. The scoop will hold about 5 cubic feet of dirt, and is usually filled after moving about 8 feet. When full, the scoop slides out of the trench, the handle is lifted to disengage the hook, and the bucket falls on its side. A loop on the bottom of the bucket offers a hold for turning the bucket bottom up, and also takes much of the wear from friction. Perforations in the bottom prevent suction from holding the dirt in the bucket. The team is backed while the scoop is drawn back to position for another cutting.

DITCHING PLOW D.

This is one of the more elaborate plows (fig. 4). The dirt is not only loosened by the plow, but it is also forced up and well to the side of the trench by the wings provided for that purpose. The full depth of the trench is not made at one cutting, but about 5 to 6 inches is removed at each passage of the plow. The trench is 10 inches wide, and the maximum depth is $2\frac{1}{2}$ feet. Attachments may be purchased to make the trench 15 inches wide and 3 feet deep. Six horses and three men (two driving the teams) are ordinarily used. The machine weighs about a ton and costs \$250. The side knives to cut the wider trench cost \$25 extra, and the device for deeper cutting costs \$25 more. The bottom of the trench must be graded by hand unless the ground surface is parallel to the grade for the tile, and even then some trimming or smoothing with the tile scoop should be done.

DITCHING PLOW E.

At first glance this machine (fig. 5) looks something like a wheel excavator, but it is merely a plow with a wheel and belt for lifting the dirt out of the trench. The plow is located under the rear of the elevating wheel, which bears the entire weight of the machine when working. The frame of the machine is lowered until the plow cuts a slice

of earth 2 to 6 inches thick, according to the kind and condition of soil; the driver controls the thickness of this slice by levers that change the distance of

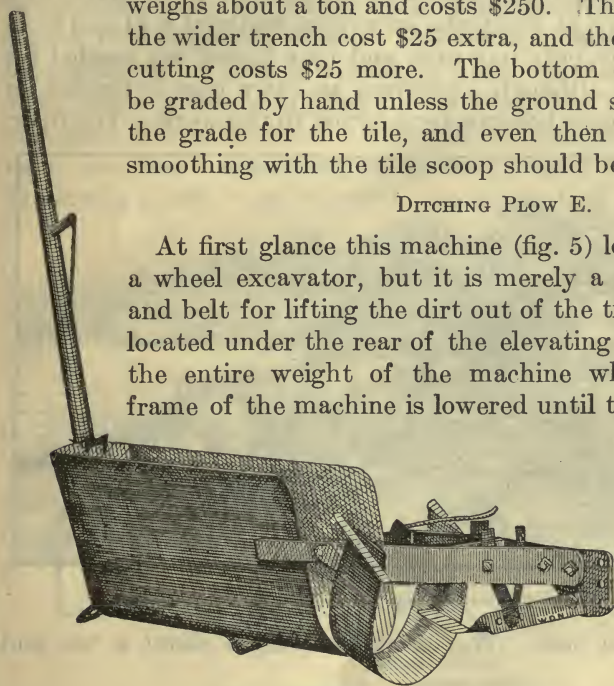


FIG. 3.—Ditching scoop C.

the plowpoint from the rim of the elevating wheel. This wheel has a wide rim, with flanges about 3 inches deep between which the 8-inch link belt fits easily. The elevating wheel is revolved by friction on the ground, and drives the link belt through a chain connection. As the dirt is loosened by the plow it is caught between the wheel and belt and is carried to the top of the machine, where it is forced off the wheel upon a dirt board that drops it beside the trench. The flanges of the large wheel act as rilling cutters in trimming the sides of the trench. The belt is kept taut by a small movable pulley and a steel spring under the rear driving seat. When one slice has been taken from the bottom of the trench, the frame of the machine, with the plow, wheel, and belt; is

further lowered and another slice is cut. This process is continued until the trench is as deep as is desired, or until the maximum depth for the machine has been reached, which is 36 to 40 inches.

In the manner described, this excavator will dig about 10 inches wide, sufficient for laying 6-inch tile. The illustration shows two trimming knives just back of the plow for making wider trenches. These are made in different sizes, for trenches up to 16 inches wide. As the trimming knives are behind the plow the dirt which they loosen is not removed until the machine makes the next cut through the trench. The dirt board may be raised or lowered to regulate, in a measure, the distance at which the excavated material is placed from the trench. Usually only one man and four horses are needed for operating this plow, although sometimes an extra man is needed for driving until the horses become accustomed to the work. The oper-

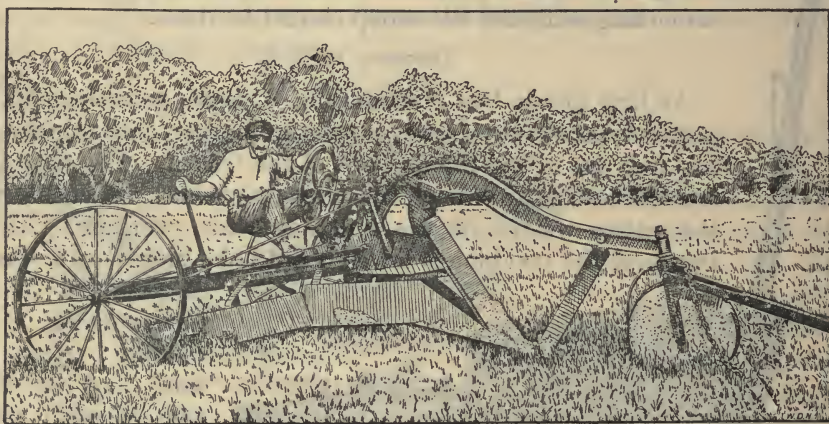


FIG. 4.—Ditching plow D.

ator sits in the rear seat. The excavator weighs about a ton and costs \$300.

WHEEL EXCAVATORS.

COMMON FEATURES.

The wheel excavators generally have steel bed frames rigidly braced, upon which the power equipment is mounted. Internal-combustion engines burning gasoline, kerosene, naphtha, or alcohol are perhaps most generally used, though steam engines and boilers are often preferred. The internal-combustion engines are preferable where it is important to avoid unnecessary weight.

The machine is usually supported upon two pairs of wheels, the front pair with flanges to prevent slipping sidewise from the line of the trench. The rear wheels carry most of the weight and therefore are large and broad. Many manufacturers now fit their machines, especially the heavier ones, with what are known as apron or cater-

pillar tractors (see figs. 7 and 11) instead of rear wheels. Each of these tractors consists of a series of wooden or iron crosspieces carried by parallel endless chains about a steel frame in such manner that the weight of the machine rests upon several crosspieces, and the large bearing surface thus obtained will support the machine upon very soft ground. As the excavator moves forward the chains lift the crosspieces at the rear and carry them to the front of the tractor.

Some machines move by applying power directly to turn the wheels or tractors, some by pulling on a cable anchored to a "dead man" buried in the ground ahead. The former method is preferable for firm soils, as no time is needed to place the "dead men." In soft soils, when power is applied to the wheels or tractors, these often slip, and the consequent "churning" causes the trench banks to cave and the machines to settle deep into the ground. When a tile-laying shield must be used, the amount of power necessary to

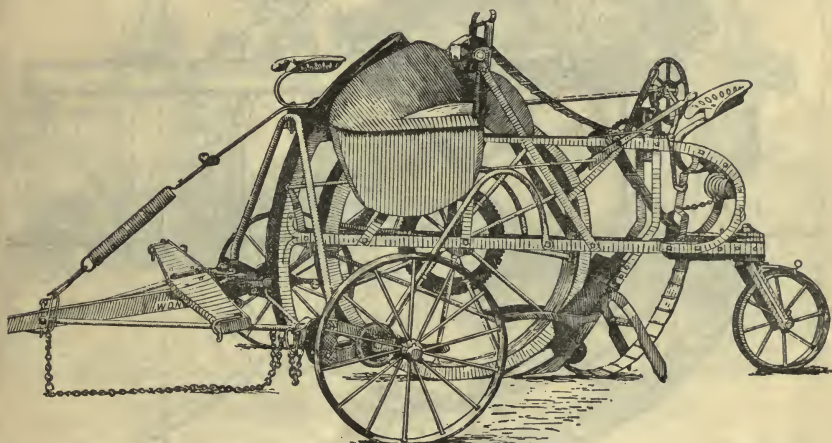


FIG. 5—Ditching plow E.

move the machine makes it impracticable to apply power directly to the tractors.

As already stated, the digging is done by buckets upon the rim of a wheel that is revolved in the trench (fig. 6), and as each bucket reaches the top of the circle the dirt falls upon a conveyor belt that can be shifted to deposit the spoil upon either side of the trench.

Levers are so arranged that the depth of excavation can be accurately controlled by the person operating the machine. An arm or gage is attached to the digging frame in such a way that the operator can sight across it to targets set along the line of the trench at a known height above the desired bottom and can thus cut true to grade.

For work in soils so soft that the sides of the trench will not stand unless supported, some machines may be fitted with shields following

close behind the digging apparatus, which keep the trench open until the tile can be placed in position. These shields are usually about 8 feet long, just sufficient to permit a man to work in them and lay the tile properly. The use of the shield of course increases the amount of power necessary to draw the machine ahead. The caving earth frequently causes the last-laid tile to "creep" forward with the machine, leaving an opening between tiles where much dirt might get into the drain and choke it. To prevent this, the man laying the tile must hold it back until it has left the shield.

MACHINE F.

The machine of this class in most common use (see fig. 7) has an

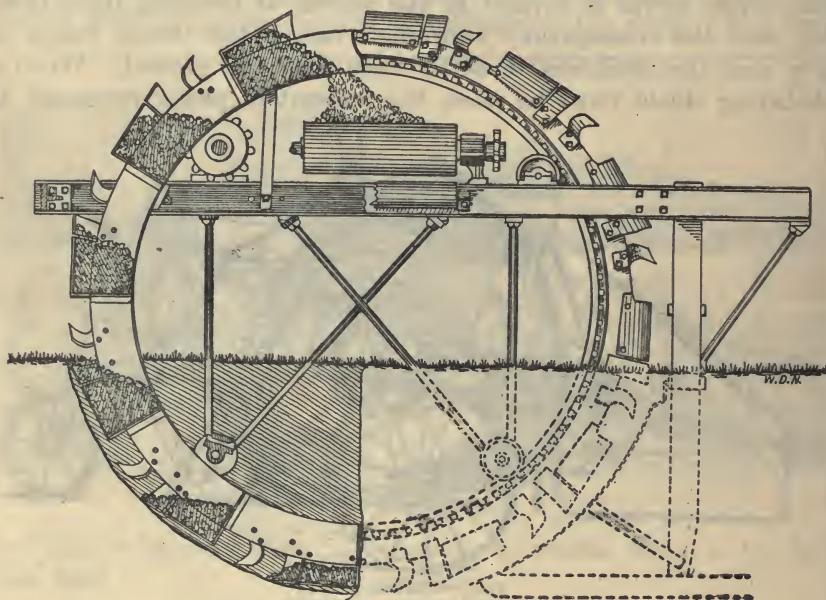


FIG. 6.—Digging mechanism of wheel excavators.

open excavating wheel; that is, a wheel with neither spokes nor hub. This wheel consists of two parallel iron rims held in their proper relative position by the buckets, which are fixed between the rims and firmly riveted to them. The rims are supported upon four pairs of small wheels (see fig. 6). One or both wheels of the pair just above the point where the digging is done are sprocket wheels, through which the power is applied. The buckets are open at the inner side, but close inside the rims is a metal plate extending nearly one-third the circumference of the excavating wheel that keeps the dirt in the buckets until it has been carried to the highest point; there it falls upon a belt conveyor, which deposits the spoil beside the trench. Between the buckets, which have semicircular cutting edges, side

cutters (see fig. 6) are bolted to the wheel for cutting the trench a little wider than the buckets and reducing the friction. The front end of the frame carrying the excavating wheel is hinged to the rear of the platform carrying the power equipment; the rear of the frame is supported on a shoe that slides on the bottom of the trench and makes a smooth, shallow groove for the tile. The maximum depth of digging is about two-thirds the diameter of the wheel. Either solid or skeleton buckets may be used. The former type is made of plates that fit the machine for digging loose, sandy soils; the latter type has bars instead of plates for the sides and bottom in order that

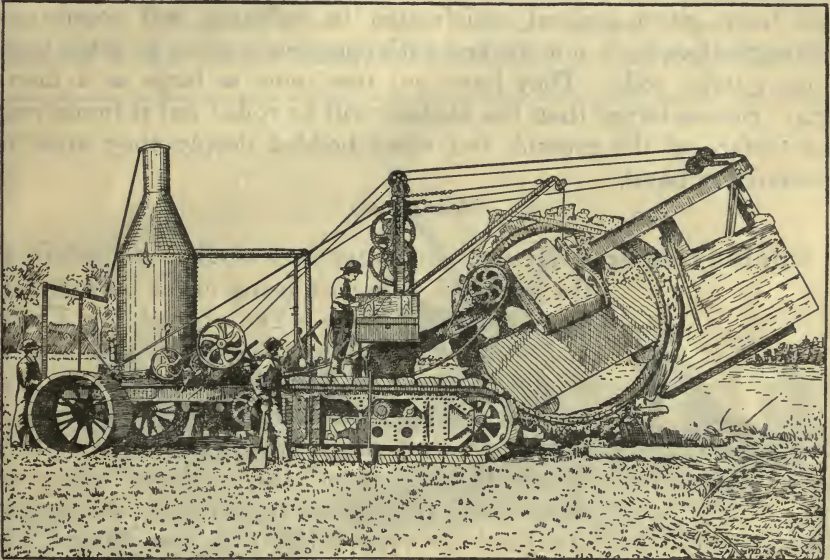


FIG. 7.—Wheel machine F, equipped with shield for use in caving soil.

wet and sticky soils will fall out more readily. Two cleaning devices are furnished to remove sticky earth from the buckets.

This machine is made in many sizes, digging trenches $11\frac{1}{2}$ inches wide by $4\frac{1}{2}$ feet deep to 54 inches wide by 12 feet deep. Its weight varies from $5\frac{1}{2}$ to 51 tons. The weights and approximate selling prices for some of the smaller sizes, equipped with steam power and wheel traction, are as follows:

Sizes, weights, and costs of machine F.

Size of trench.	Weight.	Price.	Size of trench.	Weight.	Price.
	<i>Tons.</i>			<i>Tons.</i>	
$11\frac{1}{2}$ inches by $4\frac{1}{2}$ feet.....	$5\frac{1}{2}$	\$1,200	24 inches by $7\frac{1}{2}$ feet.....	15	\$4,800
$14\frac{1}{2}$ inches by $4\frac{1}{2}$ feet.....	6 $\frac{1}{2}$	1,300	28 inches by $7\frac{1}{2}$ feet.....	18	5,200
15 inches by $5\frac{1}{2}$ feet.....	8 $\frac{1}{2}$	1,750	32 inches by $7\frac{1}{2}$ feet.....	20 $\frac{1}{2}$	5,500
20 inches by $5\frac{1}{2}$ feet.....	11	3,000	36 inches by $7\frac{1}{2}$ feet.....	24	6,500
20 inches by $7\frac{1}{2}$ feet.....	13 $\frac{1}{2}$	3,800			

The three smallest sizes can be equipped with gasoline engines instead of steam engines and boilers for \$200 to \$250 additional, and on all but the last three mentioned apron tractors can be obtained instead of wheels at an increase of \$200 to \$400 in cost. Various gears are supplied for regulating the speed of the excavating wheel and the forward movement of the machine. The latter is accomplished by power applied to the rear wheels or tractors. The road speed of this machine is about 2 miles per hour. For railroad transportation the wheels or tractors must be removed from the larger sizes.

A large number of machines of this style have been manufactured and have given general satisfaction in ordinary soil conditions, although they have not worked with complete success in some tenacious gumbo soils. They have cut tree roots as large as a man's arm. Stones larger than the buckets will be rolled out if found near the surface of the ground, but when bedded deeply they must be removed by hand.

MACHINE G.

This is a comparatively new excavator very similar to machine F, the principal difference being in the buckets (see fig. 8). Each of these is like a broad, low T with arched top, attached by the vertical stem to a rib on the wide rim of the excavating wheel. The buckets are open at the sides. Two stationary cleaners, one on each side at the top of the wheel, scrape the dirt from the buckets into short chutes that drop it at the sides of the trench.



FIG. 8.—Buckets of wheel machine G.

These buckets were designed for very sticky soils, and for work in loose material are fitted with spring backs. Either steam or internal-combustion engines are used, the latter to burn kerosene, distillate, motor spirits, or gasoline. Either wheels or apron tractors can be obtained. The limits of digging of the various sizes are the same as for machine F, though the advertised weights of a few of the smaller sizes are a little greater.

MACHINE H.

Extreme lightness and low purchase cost are the most notable features of machine H (fig. 9). It is made in only one size, digging $4\frac{1}{2}$ feet deep, but will dig three widths. The greatest width, which is 16 inches, will accommodate 14-inch tile. The total weight, ready for work, is 3,600 pounds; the price is \$1,800.

The machine is mounted upon four wheels having 8-inch tires, and the excavating wheel is placed between the front and rear axles. This wheel is raised or lowered as desired by cables passing over the top of the frame. Power is furnished by a 40-horsepower, 4-cyl-

in a gasoline motor weighing only 500 pounds, which is mounted over the rear axle. The machine is moved forward by pulling on a cable fastened to the front of the machine and looped over a pulley attached to a "dead man" ahead. It is easily drawn by team from one job to another.

The eight excavating buckets are of the open or skeleton type, and there is a spring cleaning bar for use in very sticky soil. For work in sandy material special frames or fillers are attached to the bars of the buckets. A unique feature of the buckets on this machine is that one side of each bucket is longer than the opposite side, so that one end of the cutting edge is in advance of the other and the result is a "diagonal draw" cut. Another special feature of this machine is that all the excavated material is not carried to the top

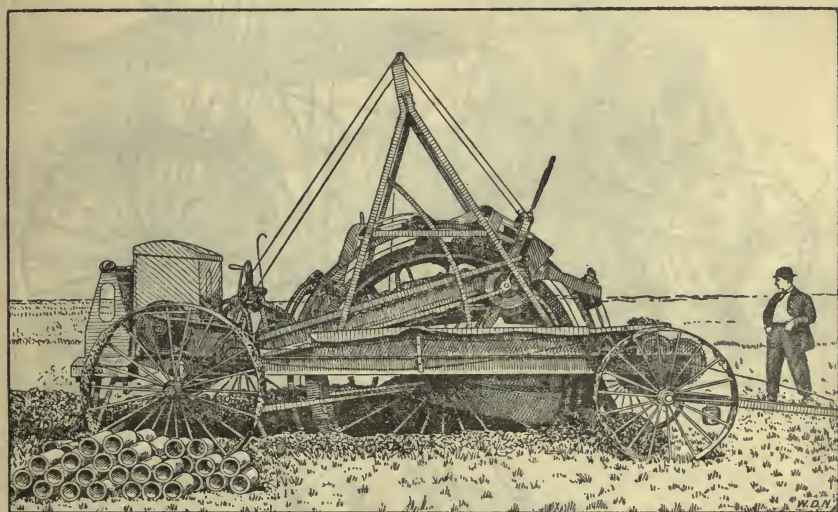


FIG. 9.—Wheel machine H.

of the wheel, but any loose earth falls out of the buckets soon after they get above the ground surface, upon a revolving cylinder that throws the dirt to the side of the trench. It is claimed that considerably less power is required to operate this machine, because the whole amount of excavated material is not lifted to the top of the wheel.

Excavator H is of rather recent manufacture, but all of this make so far tried seem to have been satisfactory. Sticky gumbo has given comparatively little trouble, and a machine has been operated in ground so soft that the wheels sank to the hubs in the mud. A crew of two men is desirable for trenching—one to operate the machine and one to clean the crumbs from the ditch and lay the tile. About 10 gallons of gasoline are used per day.

ENDLESS-CHAIN EXCAVATORS.

This class of excavator, like the wheel machines, has steel bed frames mounted upon two pairs of wheels and carrying steam engines and boilers or internal-combustion engines. Apron tractors are often used instead of the rear wheels. The digging apparatus is operated by a sprocket wheel at the upper end of the frame, receiving power through a chain drive from the engine (see fig. 10.) At the

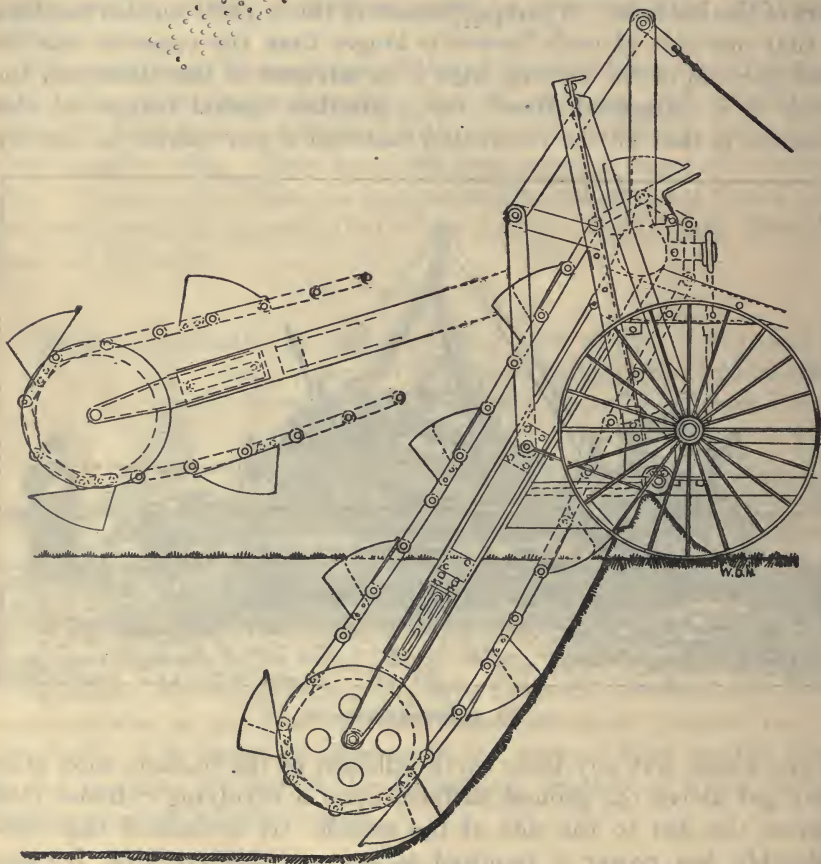


FIG. 10.—Digging mechanism of endless-chain excavators.

end of their upward movement the buckets empty their loads upon an endless belt which conveys the dirt far enough to the side that it will not fall back into the trench. Cutting knives or teeth on the lip of the bucket are often used in hard ground.

Devices for cleaning the buckets are provided. The depth of excavation is regulated by levers, gage, and targets in the same way as for the wheel excavators. Shields can be used to keep the trench from caving until the tile have been laid.

MACHINE I.

This excavator (see fig. 11) carries most of the weight on two tractors, each of 10 to 50 square feet bearing surface, depending upon the size of the machine and the character of the soil. The front wheels guide the machine and carry a little weight. The usual power equipment is a gasoline engine of the vertical water-cooled type with two to four cylinders. This is belt-connected to a friction drum, which transmits the power through a heavy sprocket chain to the excavating chain and the belt conveyer. The gaso-

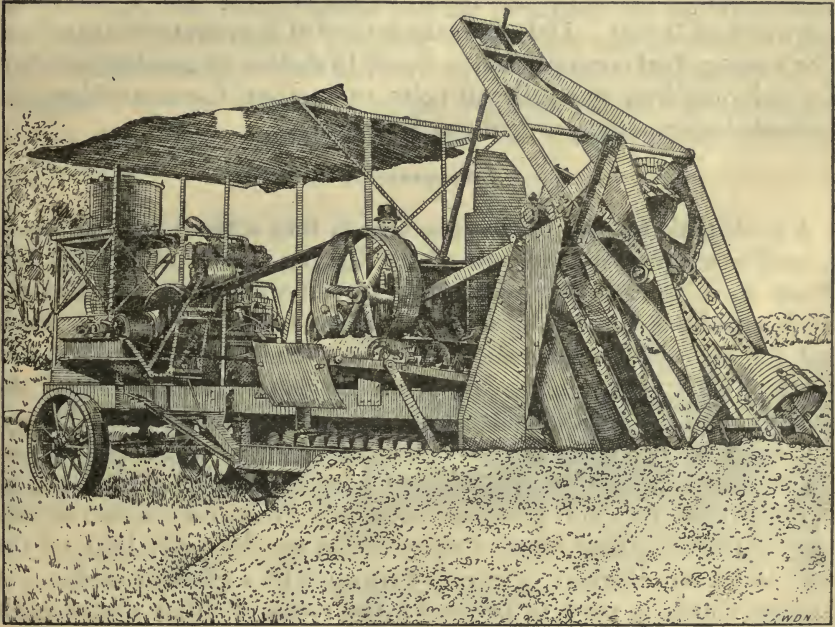


FIG. 11.—Endless-chain machine I.

line and water tanks are located ahead of the engine on the front of the bed frame. The machine moves forward by power applied directly to the tractors. Its average speed on the road, when not digging, is about $1\frac{1}{2}$ miles per hour. The manufacturers of this machine provide a device that prevents soft earth from working up between the boards forming the bearing surface of the tractor, eliminating a source of annoyance not uncommon to apron tractors generally. The excavating buckets are of the open conical scoop shape, and as each revolves about the driving wheel it is scraped by a cleaning device that causes the dirt to fall upon the belt conveyer. This conveyer can be shifted from one side to the other with little trouble, permitting the dirt to be piled on the side preferred.

The machine is made in two sizes, the smaller digging 12 to 22 inches wide and any depth not exceeding 6 feet, the larger digging 15 to 28 inches wide and any depth to 10 feet. The operator can adjust the width of the trench merely by changing the knives or reamers used with the buckets. The smaller machine weighs about 9 tons, is fitted with an 18-horsepower gasoline engine, and costs about \$3,000. The larger machine weighs about $11\frac{1}{2}$ tons and costs about \$4,000. It may be fitted with a 25-horsepower gasoline engine, or with an 18-horsepower $8\frac{1}{2}$ by $8\frac{1}{2}$ inch steam engine and 25-horsepower vertical boiler. An attachment is manufactured which will cut ditches with sloping banks, having a maximum depth of 5 feet and a maximum top width of $7\frac{1}{2}$ feet. Only one man is needed to operate this machine. The average fuel consumption is about 15 gallons of gasoline per day. For shipping from one railroad point to another, these machines can be loaded upon a flat car without dismantling.

MACHINE J.

A noticeable feature of this machine is that a third pair of wheels is used to support the rear end of the digging apparatus (see fig. 12). When working, the rear wheels are spread wide apart, so that the truck straddles the trench and the waste banks. For road travel and for railroad transportation the rear truck is narrowed to the width of the others. The front end of the frame supporting the buckets, and the greater part of the weight of the power machinery, is carried on the two large wheels of the middle truck. Spreaders can be used to widen the rims of these wheels, permitting the machine to travel over very soft ground. Both the front and the rear wheels can be steered so that turns of short radius can be made both on the road and when digging. Power is furnished by a gasoline engine. A friction clutch is used to prevent large rocks or other obstructions from breaking the machinery. This excavator ordinarily moves under power applied from the engine to the large middle wheels, but when a shield is used in the trench to prevent caving of the sides the machine is moved by pulling on a cable anchored ahead. The road speed is about $1\frac{1}{2}$ miles per hour. The digging equipment is similar in general to that of excavator I already described. The buckets are of a special conical shape. The cleaning device is stationary, with a spring that makes the cleaner fit each bucket exactly, and has worked exceptionally well in sticky gumbo soil. There are two conveyor belts, one on each side, which meet under the middle of the bucket being dumped. When both conveyors are in a horizontal position the dirt is deposited on both sides of the trench; all may be placed on one side by merely raising the conveyor on the opposite side to a vertical position. The mechanism regulating the depth of cut is mounted upon the trailer frame that connects the

rear wheels and the forward part of the machine, and can be operated either by hand or by power from the engine.

Excavator J is made in three sizes. The smallest machine cuts 16 to 26 inches wide and 9 feet deep, weighs about 8 tons, is equipped with a 25-horsepower, 2-cylinder, opposed type, internal-combustion engine, and costs about \$4,000. The middle size cuts 28 to 47 inches wide and 12 feet deep, weighs about 15 tons, has a 40-horsepower engine, and costs about \$6,000. The largest machine cuts 28 to 58 inches wide and 20 feet deep, weighs about 18 tons, has a 40-horsepower engine, and costs about \$6,500. An extension for digging deeper than the stated limits can be furnished for the two larger machines. Motor spirits, gasoline, or kerosene can be used for fuel. This machine weighs less than any other practical design, capable of digging to the same limits, that has yet been placed on the market. In the two larger sizes this excavator has a crane mounted on the

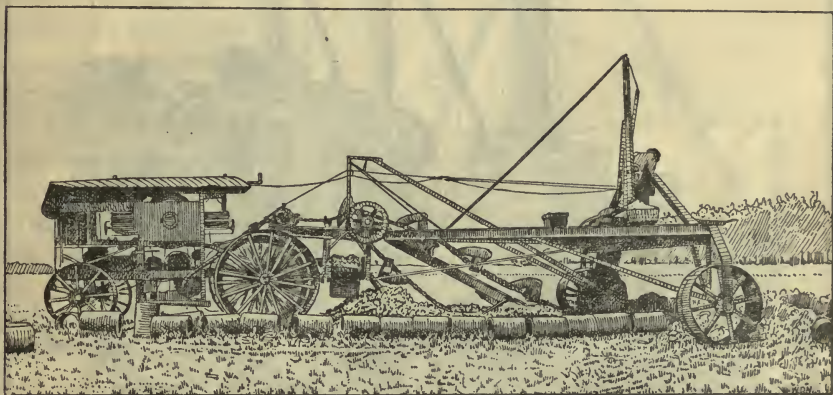


FIG. 12.—Endless-chain machine J.

trailer frame for lifting the tile from the side into the bottom of the trench. The windlass for the crane is usually worked by hand, but it could be operated by power from the engine. The entire trailer with the digging mechanism can be detached by removing one bolt and disconnecting the hoisting cable and the chain driving the buckets; the forward part of the machine then can be used as an ordinary traction engine for hauling or other power purposes. To run either of the larger machines two men are necessary—one to operate the traction and one to regulate the depth of cutting and to operate the tile crane.

MACHINE K.

The unique feature of machine K (see fig. 13) is that the excavating buckets are drawn vertically up the end of the trench instead of at a considerable angle. The advantage of this feature is that the machine will cut curves of unusually short radius. The machine moves on four

wheels, the rear pair large and having 24-inch tires that can be increased by spreaders to 48-inch width. The machine travels on the road at about $2\frac{1}{2}$ miles per hour. There are 10 cylindrical buckets attached to a roller chain, which travels on a rigid frame shaped like an inverted L, with the vertical stem toward the front of the machine. The buckets are filled as they rise vertically from the trench, then pass back over the horizontal part of the digging frame, and drop their loads upon the belt conveyor as they turn about the end of the frame. Returning forward horizontally they pass over a cleaning

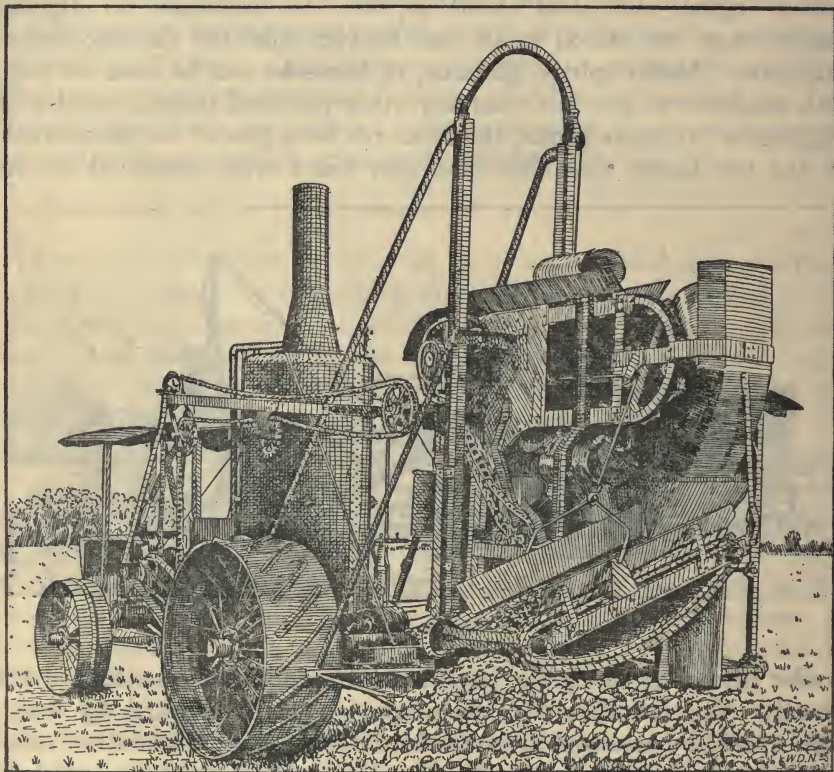


FIG. 13.—Endless-chain machine K.

plate before turning downward to the bottom of the trench. The cleaning plate just fits the buckets and is especially valuable in very sticky soils. It is in turn kept clean by a gear-driven scraper. The buckets are slotted on the outer side and the bottoms are hinged to permit passage over the cleaning device and its support. A “crumber” is dragged behind the excavating frame, to scrape up any loose earth and to make a groove in the bottom of the trench that will keep the tile in perfect alignment. The depth of cut is regulated accurately by raising or lowering vertically the whole digging frame and mechanism.

This vertical-cut excavator is made in two sizes. The smaller size cuts 13 to 17 inches wide and $6\frac{1}{2}$ feet deep, has a 25-horsepower, 2-cylinder, opposed type gasoline engine, weighs about $5\frac{1}{2}$ tons, and costs approximately \$3,000. The larger size cuts 17 to 24 inches wide and 9 feet deep, is equipped with a 15-horsepower steam engine and 18 horsepower vertical boiler, weighs 10 tons, and costs about \$4,000. The gasoline engine of the smaller machine is mounted over the forward truck but the steam engine and boiler are mounted between the two trucks on a strong bed frame with the water tank in front. The digging apparatus on each size is placed just behind the rear truck.

In beginning a trench, a shallow hole must be excavated into which the digging frame is lowered before the buckets can be started. The smaller machine can be operated by one man. This size can cut on a curve of 50 feet radius. The larger size requires a crew of three men—one to operate the digging machinery, one to tend the engine and boiler, and one to haul water. About 30 barrels of water and a ton of coal are needed per day.

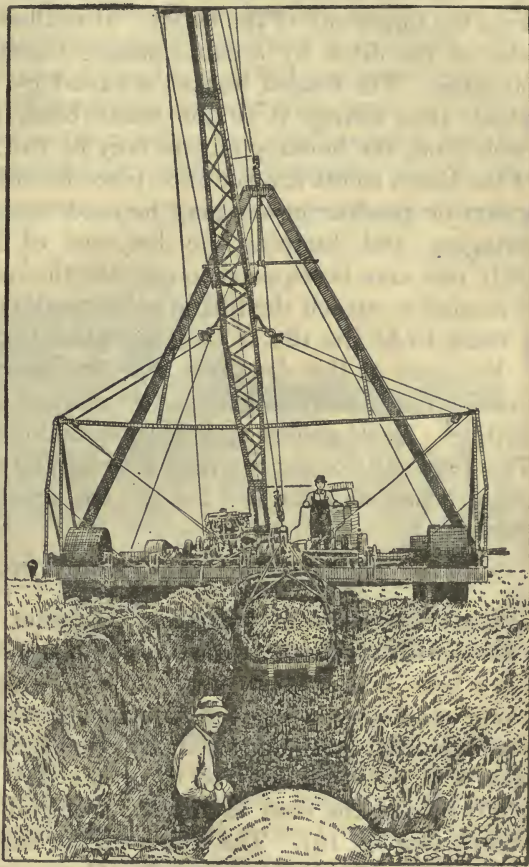


FIG. 14.—Scraper machine L.

SCRAPER EXCAVATORS.

As previously stated, the machines in this class are merely adaptations of excavators originally designed for digging large ditches. They are not suited to trenching for small tile, and seem to be used entirely for large tile mains.

MACHINE L.

The illustration (fig. 14) shows a drag-line excavator of ordinary design being used for laying a main drain of very large tile. Upon the bed-frame is mounted a swinging boom, the upper end of which is supported by a cable from the top of the A-frame, also mounted upon the bed of the machine. The bucket or scoop hangs on a cable from the upper end of the boom. It is filled by being dragged lengthwise of the ditch by a cable pulling directly from the front of the machine. The loaded bucket is raised by the rope from the boom, which then swings it to the waste bank to be dumped. Another cable from the hoisting engine may be run over a sheave on the end of the boom to lift the tile into place from beside the trench. Either steam or gasoline power may be used to do all the work of digging, swinging, and dumping the dirt, and of lifting the tile into place. Only one man is required to operate the machine, but a second man is needed to attach the lifting cable to the tile beside the trench, and a third to fit the tile as they are placed in position.

Machines of this drag-line type are sometimes fitted with a guide rail for the bucket to give better control of the place and depth of cutting. Such guides may help in making a clean, smooth trench. This type can not dig to grade as accurately as the wheel and endless-chain types, and the bed for the tile must often be smoothed with shovels.

BACK-FILLING AND TILE-LAYING DEVICES.

Some operators of trenching machines have equipped the excavators with mechanical devices for filling the trenches after the tile have been laid. These may be used with either wheel or endless-chain machines, whenever sufficient power is available. One such arrangement, manufactured by the makers of excavator J, consists of a conveyor belt to carry the dirt from the excavator to a point behind the man laying the tile, and there to dump it into the trench (see fig. 15). The frame supporting the belt is mounted on a truck that straddles the trench. Considerable power is required to operate this conveyor.

Simple devices are V-shaped plows attached to the excavators by means of cables. They may be made of either metal or wood. As the excavator moves forward the back-filler is dragged along, wide end foremost and one arm on each side of the trench, scraping the waste banks into the ditch.

Steel chutes for laying tile up to 12 inches in diameter, without requiring a man in the trench, have been attached to trenching machines. These have not been wholly successful, at least partly because tile slightly irregular in form can not be fitted together as is done when they are laid by hand.

COST OF TRENCHING BY MACHINERY.

The cost of trenching by machinery depends upon a number of factors, some of which are often overlooked in considering the purchase of such a machine.

The cost of operation per day will depend upon the number of men and teams employed, the wages paid, and the amount and cost of fuel. In respect to labor, the internal-combustion engine has the advantage, for usually only one skilled operator is needed, while steam equipment requires also a fireman and a team with driver to haul fuel and water. Not all workmen are paid when work is delayed by unfavorable conditions or for repairs, but the operator and frequently his helper are employed in making the repairs, and it may

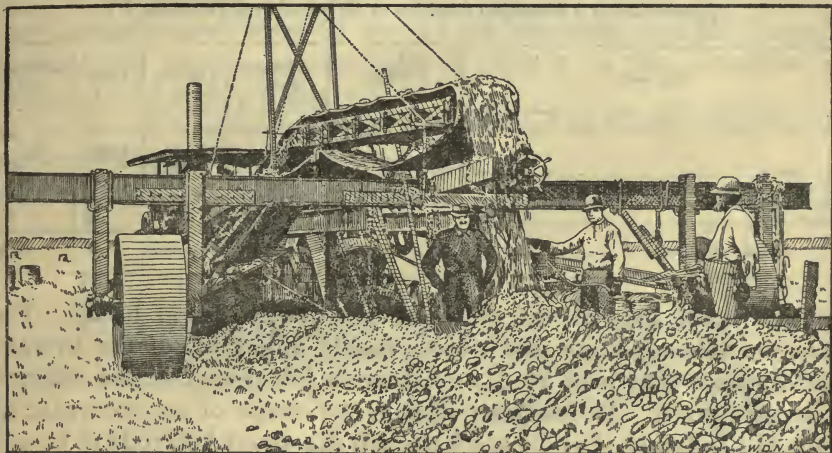


FIG. 15.—Back-filling belt conveyor, attached to machine J.

sometimes be necessary to pay the operator for time lost owing to such causes as rain. Laying tile, blinding,¹ and back-filling the trenches of course require further labor, which would be the same for any machine or for hand labor, unless a back-filling device is attached to the excavator. In tile-drain contracts only three items are usually covered: trenching, laying, and blinding.

The amount of work done per day will depend upon the soil conditions, the strength and efficiency of the machine, and the skill of the workmen. One of the most difficult soils to work is a wet, sticky clay; a sandy subsoil will often cause difficulty. The presence of large stones or tree roots will of course interfere greatly, more so than with hand ditching. Very hard subsoil may make progress slow. Some of the machines have worked through 15 inches of frost, but this is severe work for any excavator. Some clays become

¹ "Blinding" is carefully placing the first few inches of earth around and over the tile to hold it in position and protect it when the trench is being filled.

baked hard enough in dry periods to make trenching slow. These various conditions will show the weak points of a machine, and may cause considerable expense for repairs, due not only to cost of repair work, but also to time lost.

It is interesting to note a few instances of work by machines. In a saturated loam soil, a machine F dug 105 rods of trench 14½ inches wide and 40 inches deep in 9 hours (an unusually good day's run). In a heavy, sticky clay, another machine of the same type dug 280 rods of 12-inch trench 3½ to 5½ feet deep at the rate of 61 rods in 10 hours, the best day's work being 91 rods. On another job where the soil was saturated at depths of 3 to 5 feet, progress by a similar machine on a 12-inch trench was as follows:

Performance of a trenching machine of the wheel type (machine F).

Top soil.	Subsoil.	Average depth.	Length.	Time.	Average rate.
		<i>Feet.</i>	<i>Rods.</i>	<i>Days.</i>	<i>Rods per day.</i>
Clay loam.....	Silty clay.....	3.7	30.3	1	30.3
Silty clay loam.....	do.....	5 to 5.5	42.5	3	14.2
Silty clay loam.....	Silty sand.....	5 to 5.5	21.2	2	10.6
Sandy loam.....	do.....	5 to 5.5	212.0	23	9.2
Totals and means.....		5.1	306.0	29	10.55

In the sandy subsoil the sides of the trench caved badly. The rates on this work are much more nearly indicative of the average performance that may be expected for a job than the two selected examples given. In northern Illinois the owner of an excavator of type H has found that his machine will dig about 100 rods of trench 3 feet deep per 10 hours' actual digging.

The matter of lost time is of great importance, for the owner is usually losing money when his machine is not digging. The portion of a year during which a machine does not work is surprisingly great, even to many drainage contractors, and will explain why trenching with a machine costs so much more than one ordinarily will reckon even after watching the machine work for several days under adverse conditions. While a machine is on the work there is loss due to stormy weather, and sometimes due to flooding of lowlands; there are delays for repairs, including waits for new machine parts; and there is time spent in moving from one trench to another. Interest and depreciation charges accrue during all these delays, as well as on Sundays and while the machine is being transported between jobs or lies idle waiting for new work. In the northern States there are two to four months of the year when frozen ground and cold weather prevent work of this kind, except at rates too high for farm drainage. A contractor who has his machine actually digging 200 days in the year is fortunate.

It will be helpful to examine the record of one large contract on which the conditions were fairly good. The machine of type F arrived June 24 and began digging July 3; trenching was completed October 1. Of the 100 days the machine was on the job, there were 14 Sundays, 61 days of machine work, and 25 days lost on account of repairs, rain, and miscellaneous delays. The main drain, of 5-inch to 12-inch tile, was 358 rods long and of about 3.9 feet average depth. The lateral drains, of 4-inch and 5-inch tile, had a total length of 6,055 rods and an average depth of about $2\frac{1}{2}$ feet. Of the 61 days of work, 12 were required for the main drain and 49 for the laterals. The average rates of progress, considering only the days of actual work, were 29.8 rods per day for the main drain, and 123.6 rods per day for the laterals. If the 25 lost days be included, the working days actually used were 15 and 71 for the main and the laterals, respectively, and the average rates of digging are then computed as 23.9 and 85.3 rods per day.

The cost of this contract may be estimated as follows, since rather accurate data are available:

Freight on machine, water wagon, etc.....	\$78.54
Repairs and renewals.....	109.92
Fuel, about 24 tons coal, delivered.....	94.90
Lubricating oil.....	13.95
Labor:	
Operator, at $22\frac{1}{2}$ cents per hour.....	\$123.58
Fireman, at 20 cents per hour.....	109.80
Team and driver, at \$2 per day.....	122.00
	355.38
Horse feed.....	60.12
Incidentals.....	28.85
Camp equipment for laborers.....	29.55
Total cost of operation.....	771.21

To the foregoing cost of operation must be added the cost of superintendence and of "overhead" charges paid by the contractor, such as office rent, clerical hire, and travel in securing the contract; these might be assumed very roughly as \$150. While the machine was on the job only 100 days, there should be added the time that the machine was in transit to the job, the time used for repairs before shipment to the work (in this case new boiler flues were placed and some machining of parts was done), and a proportionate part of the time the machine is idle between contracts and on account of winter weather. It is reasonable to assume that interest and depreciation should be charged for about five months. The machine probably cost, new, about \$1,750. Depreciation on machinery of this kind is especially difficult to determine accurately, but it may be assumed that by the end of four years the excavator will have been practically rebuilt; the bed and perhaps the engine will be in fair condition, but

renewals of other parts will have been made many times. On this basis the cost of that part of the contract covering the trenching machine's work is computed.

Cost of operation.....	\$770
Superintendence and overhead charges.....	150
Interest.....	50
Depreciation.....	200
Total.....	1,170

Dividing this cost in the ratio of 15 to 71, the days required for the main and the laterals, the cost of trenching only is computed as 57 cents per rod for the main and 16 cents per rod for the laterals. If the labor for laying and blinding the tile cost \$3.82 per day for the 61 days the machine was digging, the total cost of trenching, laying, and blinding was 70 cents per rod for the main, and 19 cents per rod for the laterals. The main averaged 3.9 feet deep, and one-third was wide enough for 10-inch and 12-inch tile; the laterals averaged 2½ feet deep, all of minimum width. The cost for the main is unusually high, while that for the laterals is unusually low. In the early part of the work, including the work on the main, digging was slow because the ground was very dry and hard. Several buried stumps caused minor breaks and some delay. Because one lateral was dug and the tile laid, and rain came before connection was made to the main, about 500 feet of 5-inch tile had to be removed, cleaned, and relaid.

It is interesting to compare the foregoing contract job with the following work done by a landowner. A second-hand steam trencher of type F was bought for \$500 on January 8, and not long after the completion of the work on November 5 it was sold for \$400. The work on this farm was the total done by the machine in the year. The total length of trenching was 3,830 rods, the average depth about 32 inches; 5-inch tile was the largest laid. The cost items were:

Freight on machine.....	\$20.00
Travel to purchase machine.....	17.95
Repairs and renewals.....	203.09
Fuel:	
4 tons coal.....	\$20.00
50 cords wood (cut on farm).....	100.00
	120.00
Oil and grease.....	7.10
Labor:	
Operator, at 20 cents per hour.....	\$276.80
Helper, at 15 cents per hour.....	207.60
Team and driver, 17½ cents per hour.....	121.10
	605.50
Interest on cost of machine.....	30.00
Depreciation.....	100.00
Total cost of trenching.....	1,103.64

The cost per rod was thus $28\frac{1}{4}$ cents. The cost of laying and blinding the tile was \$331.70 for 3,830 rods, or $8\frac{1}{2}$ cents, making the total cost $37\frac{1}{4}$ cents per rod for trenching, laying, and blinding. The top soil was loam, overlying a compact silty clay subsoil. A good many small bowlders were encountered, and hardpan was sometimes found where the cutting was as deep as $3\frac{1}{2}$ feet.

A machine of type H worked from January 1 to April 18 in stiff, heavy clay. The total length of drain was 3,075 rods, including about 1,200 feet of 10-inch and 12-inch tile; the average depth $3\frac{1}{4}$ feet. For about 600 feet, 6 inches of lime rock was encountered that required blasting. About one-third of the length was through a hardpan subsoil that could not be shoveled by hand until it had been loosened with picks. Frequent rains kept the ground saturated most of the time. Of the 92 working days, 32 were lost on account of rain and repairs. The cost of trenching, laying, and blinding, including setting grade stakes and leveling, but not back-filling, was as follows:

Labor.....	\$606.64
Repairs.....	46.65
Gasoline, oil, etc.....	58.27
Board for part of crew.....	51.00
Interest and depreciation.....	240.00
Total.....	<u>1,002.56</u>

This is equivalent to 32.6 cents per rod. There was no freight to be paid, and the farmer moved the machine from one drain line to the next. Interest and depreciation are computed at \$4 per day of actual digging, which seems reasonable for this machine, if kept fairly busy.

The same machine worked from April 20 to June 6 in a sandy loam with weather and soil conditions favorable, although one rain caused some little caving of trenches. The length of drain was 1,450 rods, including 600 feet of 10-inch and 12-inch tile; the average depth was 3 feet. Of the 42 working days, 3 were lost on account of rain, 3 for repairs, and 8 waiting for necessary work by another contractor, all of which are charged in the following cost:

Labor.....	\$259.90
Gasoline, oil, etc.....	31.50
Repairs.....	16.40
Board for men.....	30.00
Interest and depreciation.....	112.00
Total.....	<u>449.80</u>

This is equivalent to 31 cents per rod for setting grade stakes, leveling, trenching, laying, and back-filling. The cost of the delay for another contractor amounted to \$38.80, or 2.7 cents per rod. There were no freight or hauling expenses on this contract.

The foregoing figures show a considerably greater cost than such work is generally supposed to involve; however, the writer believes that when the total expense and the amount of work done in the whole year are counted up the costs given will be found not far from the average.

For tile trenching and laying by hand, where experienced men are employed, the rate of progress for one bottom man and one top man for the smaller size of tile laid not more than 3 feet deep, is ordinarily 15 to 30 rods per day, depending largely upon soil conditions. In some sections of the country, where the use of unskilled colored labor is necessary, the same number of men will put in, even with good supervision, only 5 to 8 rods per day per man; the cost for this labor per man is, of course, considerably less than for the other. Hand trenching, laying, and blinding by experienced men in good loamy soils costs from 25 to 40 cents per rod for depths not exceeding 36 inches, and in sticky soils from 40 to 50 cents per rod.

It will be noted that there is not a great difference in the cost of trenching by hand and by machine. The advantage of the latter method is in the shorter time required to install drains and the less trouble in securing the few workmen wanted. Men capable of satisfactorily operating a trenching machine can usually be found, even where it is impossible to secure workmen to do acceptable hand trenching without close and constant supervision. On the other hand, a farmer buying an expensive machine to do a small amount of work might experience some difficulty in keeping it busy with profit until it can be sold.

SELECTING A TRENCHING MACHINE.

In selecting a trenching machine, the prospective purchaser should consider carefully the amount of work to be done by it, the dimensions of the trenches to be dug, the nature of the soil to be excavated, and other conditions of work.

The wheel type of excavator is most generally used for installing farm drains, probably owing to a lower cost for the smaller sizes than the cost of the chain type. Machines of the latter kind have greater range in size of trench than wheel excavators of the same weight, and seem to be better adapted for work when there is a great deal of 8-inch tile and larger. When the greater portion of a job is small tile at ordinary depths, of course the excavator should be suited to the major part. Some of the machines are so constructed that the excavating mechanism can be easily detached, leaving the other part available as a traction engine or to furnish power for running miscellaneous farm machinery.

The weight of the excavator is important in digging soft earth, and may require the use of apron tractors instead of the less expensive wheels. Sometimes internal-combustion engines are preferred to

steam equipment because they weigh less. Internal-combustion engines are also quite popular for the smaller machines because the number of men required for operation is less, but they are not so dependable for continuous operation as steam engines, and the latter equipment is therefore generally preferred for large machines. In some localities gasoline and similar fuels are not easily obtainable, and if wood is plenty and cheap this may make steam machinery more desirable. When the same engine is to be used for grinding feed and for similar work, the readiness with which internal-combustion engines can be started makes them desirable.

A trenching machine should be constructed of good materials and be well proportioned for strength. Simplicity of construction is desirable. The great loss of time on a job due to faulty operation of internal-combustion engines and to delays for repairing broken chains, bolts, gears, and other pieces, requires the elimination of as many parts as practicable. The cost of repairs depends a great deal upon the skill and care of the operator. Comparatively little time is consumed in moving from one drain to another.

While it is manifestly impracticable to make a hard and fast rule which the landowner may apply in selecting a trenching machine for his particular needs, the following general statements may be of assistance.

If a landowner expects to install 100 rods of tile drain in soil which would require picking, but which contains no rock, he would be justified in buying a ditching plow costing as much as \$20. If he proposes to construct 1,500 rods of tile drain in soil free from rock and large roots, the landowner can well afford to purchase a horse-drawn ditching plow costing from \$250 to \$300; and if it be assumed that the owner can sell his machine, when his ditching is completed, for \$100, he would be justified in purchasing such a machine for the construction of 1,000 rods of drain. For the installation of as much as 5,000 rods of drain in a soil free from rock and large roots, the purchase of a power-driven trenching machine costing as much as \$1,500 probably would be justified, on the assumption that the machine could subsequently be sold for one-half its original cost. Very economical results are often to be obtained where several landowners unite in the purchase of such a trenching machine as is most suitable for their combined work.

Machines costing over \$1,800 are suitable for contractors, owners of large plantations, and others having an unusual amount of trenching to do. However, landowners who have at least 5,000 rods of drain to construct and who intend to buy a power tractor, should investigate the suitability of some trencher having a detachable tractor that, when separated from the digging apparatus, would fulfill the purposes of any other tractor.

CONCLUSIONS.

In comparing the real costs of different machines and implements one must consider not only the purchase price and the operating cost for fuel, oil, and labor, but also repairs, interest on the investment, and depreciation. The interest on \$20 invested in a plow is not large; repairs will cost little, and the implement will last many years. For a \$3,000 excavator the interest charge would be \$180 per year at 6 per cent, depreciation might be \$450 or more per year, and repairs would be considerable. Operating expenses and repair costs depend largely upon the amount of work done, but interest and depreciation continue whether the machine is in operation or stands idle. Therefore the owner of an expensive machine must keep it busy a large part of the time if his investment is to be profitable.

On large jobs costly excavators may profitably be employed, but an inexpensive tool may be most economical for work that can well be done a little at a time when men and teams regularly employed on the farm might otherwise be idle. One of the greatest advantages of the large machines, from the farmer's viewpoint, is that the work is done rapidly; from a contractor's viewpoint there is often great advantage in using only a few men, as the employment of large numbers often involves labor difficulties. The larger machines can be used most advantageously where the drains are long and parallel.

Work is slow and costly in caving soil, in boiling quicksand, and in sticky gumbo. Large stones and roots cause annoyance and delay, and if in large quantity may make hand spading the cheapest method of excavation.

The cost data given on the preceding pages must be used with extreme caution, principally because the kind and condition of the soil and the skill of the operator affect the cost so greatly. The quality of the work also depends upon the carefulness and experience of the operator. Each purchaser must consider the limits of the work he will have to do and the conditions to be encountered, then determine what machine will best meet the requirements as a whole.

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Contribution from the Bureau of Entomology, L. O. Howard, Chief.

HYDROCYANIC-ACID GAS AGAINST HOUSEHOLD INSECTS.¹

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Entomological Assistant.

INTRODUCTION.

The purpose of this bulletin is to enable the reader to use hydrocyanic-acid gas safely and effectively as a means of destroying the various insect pests of the household, such as bedbugs, fleas, cockroaches, ants, clothes moths, and carpet beetles.

By way of caution it should be stated at the outset that hydrocyanic-acid gas is extremely poisonous and is fatal to human beings if breathed in any quantity, while the chemicals used in generating the gas—sodium cyanid or potassium cyanid and sulphuric acid—are also very poisonous, the cyanid being necessarily fatal if only a small piece be eaten and the sulphuric acid burning badly when coming in contact with the skin. Special attention is called to the full discussion of this subject on pages 6 to 8, under the heading "The cyanid and gas a deadly poison." *The chemicals must be handled with the greatest care and the fumigation process must not be undertaken until it is thoroughly understood in every particular.*

Hydrocyanic-acid gas has been for more than 20 years one of the most effective known fumigants in use against noxious insects. It has a wide range of applicability, including the control of scale insects on citrus and nursery stock and the fumigation of greenhouses and cold frames, and it is a standard remedy against insects in mills and warehouses.² As a fumigant against household insects it has

¹ A revision of Circular No. 163 of the Bureau of Entomology.

² Entomologists have long noticed that insects vary greatly in their susceptibility to cyanid fumes. The ordinary killing bottle used in making collections contains cyanid of potassium, or cyanid of sodium, covered with plaster of Paris, which the fumes of the cyanid penetrate. Certain weevils, especially hard-bodied forms, will frequently be left overnight in a cyanid bottle and recover after being removed. It has been noticed also that in greenhouses certain insects recover after fumigation with hydrocyanic-acid gas.

been in use since 1898 and has proved so uniformly effective for this purpose when properly applied that in spite of its extremely poisonous character it has almost entirely replaced other and less poisonous gases.¹ Rats and mice are also killed by its use, and it fortunately has the effect of first causing these animals to rush out from their holes into the open, so that the subsequent annoyance of dead rats and mice in walls and under floorings is not experienced. The absence of any bleaching or tarnishing tendency when pure materials are used is also a strong point in its favor.

MATERIALS USED IN THE FUMIGATION PROCESS AND THEIR PROPORTIONS.

In the formation of hydrocyanic-acid gas for the purposes of fumigation sulphuric acid in a diluted form is permitted to act on either sodium cyanid or potassium cyanid. In the resulting reaction hydrocyanic-acid gas is liberated, while the remainder of the salt unites with the sulphuric acid to form sodium or potassium sulphate, nonpoisonous compounds. Up to the year 1909 cyanid of potassium was used almost entirely for this purpose, but since that time cyanid of sodium has taken the place of potassium cyanid and the latter is not now easily obtainable.² Sodium cyanid in its pure form liberates nearly a third more hydrocyanic-acid gas per pound than does cyanid of potassium and is a satisfactory substitute for potassium cyanid. Its slightly greater cost is balanced by the larger yield of gas. Cyanid of sodium is now being manufactured in special 1-ounce molds for fumigation purposes.

¹ Carbon bisulphid has sometimes been recommended as a substitute for hydrocyanic-acid gas. The extreme inflammability of this substance, however, and the explosiveness of its vapor when confined render it perhaps less available, and the danger in its use more than counteracts the danger to human beings from hydrocyanic-acid gas. It has been found, moreover, that hydrocyanic-acid gas is much more effective for the control of all groups of household insects, with the exception of the beetles, than is the other fumigant.

² Should potassium cyanid be obtainable, and used in the fumigation, 1 fluid ounce of commercial sulphuric acid (about 1.84 sp. gr., or 66° Baumé) diluted with 3 fluid ounces of water (to increase the bulk of the liquid and insure complete chemical action) and 1 ounce of high-grade (98 per cent) cyanid of potassium must be used for every 100 cubic feet of space. The formula per hundred cubic feet, therefore, is as follows:

Potassium cyanid (98 per cent).....	avoirdupois ounce..	1
Commercial sulphuric acid.....	fluid ounce..	1
Water.....	fluid ounces..	3

Potassium cyanid was formerly obtainable in various technical grades, ranging between 40 per cent and 98 to 100 per cent actual cyanid, the remainder being an inert salt, usually sodium carbonate or sodium chlorid, which is of no value in fumigation and in the case of sodium chlorid is a positive detriment, as this substance, acted upon by sulphuric acid, produces hydrochloric acid, which decomposes the hydrocyanic-acid gas. In cases of extreme adulteration as much as 60 per cent of the fumigant may be decomposed in this manner, resulting in inferior effectiveness and tending to tarnish polished metal surfaces exposed to the gas. If chemically pure cyanid is used little tarnishing results.

In the use of sodium cyanid the grade known as "98 to 99 per cent"¹ should be procured, and combined with the other materials according to the following formula:²

Sodium cyanid-----	avoirdupois ounce--	1
Sulphuric acid-----	fluid ounces--	1½
Water -----	do-----	3

In this combination sufficient sulphuric acid is added to liberate completely the excess hydrocyanic acid in the sodium cyanid, since in the use of this chemical a greater amount of sulphuric acid is necessary for the complete exhaustion of the cyanid.

For loosely constructed frame houses the foregoing amounts may be doubled for each 100 cubic feet. The cyanid costs from 25 to 50 cents a pound, and the sulphuric acid (thick or more sirupy commercial brand) about 4 cents a pound.

The purity of the cyanid and sulphuric acid to the degree indicated is essential to the success of the fumigation.

Druggists and other retail dealers generally have in stock only impure grades of sodium cyanid, used for other technical purposes but unsuitable for fumigation on account of the greater or less percentage of sodium chlorid (common salt) and other adulterants contained. The presence of salt, as noted in relation to potassium cyanid (see footnote², p. 2), greatly reduces the amount of hydrocyanic-acid gas given off, and it is therefore highly important to insist on the best commercial grade of sodium cyanid, known as 98-99 per cent, containing 51 per cent cyanogen, such as is manufactured especially for fumigation purposes. The greater amount of cyanogen (available hydrocyanic-acid gas) in cyanid of sodium necessitates the use of a correspondingly greater amount of acid, as indicated in the formula for sodium cyanid.

DIRECTIONS FOR FUMIGATION.

Before beginning the fumigation the house must be vacated. It is not necessary to remove any of the furniture or household belongings unless of polished nickel or brass, which may tarnish a little. Liquid or moist foods, as milk, meats, or other larder supplies that are not dry and might absorb the gas, should be removed from the house. All fires should be put out; for while the gas will not burn at the dilution employed in fumigation, it is as well to take no risks.

The cubic contents of each room on each floor should be carefully computed and a tabular statement prepared, such as the one given

¹ This grade was formerly known as 128-130 per cent cyanid, since an equal amount by weight of chemically pure sodium cyanid liberates 33 per cent more hydrocyanic-acid gas than does pure potassium cyanid, and this was expressed by designating the pure sodium cyanid as 133 per cent.

² For rapid work it may be stated that in either of the foregoing formulas, where the cyanid is weighed out in pounds avoirdupois, the same proportions may be used as expressed in the formulas, the acid and water being measured in pints.

below, designating for each floor and the different rooms the capacity and the amount of water, acid, and cyanid needed.

Table designating rooms, capacity, and amounts of chemicals.

Floor.	Room.	Cubic feet.	Water.	Acid.	Cyanid.
			<i>Fl. oz.</i>	<i>Fl. oz.</i>	<i>Ard. oz.</i>
Fourth.....	Garret.....	17,000	210	70	70
	Front.....	2,800	84	28	28
Third.....	Middle.....	1,400	42	14	14
	Back.....	2,200	66	22	22
	Front.....	15,500	165	55	55
Second.....	Middle.....	2,200	66	22	22
	Back.....	2,000	60	20	20
	Parlor.....	14,400	132	44	44
First.....	Middle.....	2,400	72	24	24
	Dining.....	2,900	87	29	29
	Servant's.....	1,200	36	12	12
Basement.....	Hall.....	2,000	60	20	20
	Kitchen.....	1,800	54	18	18
Total.....		37,800	1,138	378	378

The house is prepared for treatment by seeing that all the windows are closed and calked, if of loose construction, with wet paper or cotton batting tucked tightly into the crevices. Gummed paper strips are obtainable for this purpose and may be pasted over the crevices in the doors and windows, making the room practically gas-tight. As the building must be aired by opening the windows from the outside, those selected to be opened should be examined to see that they pull down easily, and if too high to be reached from the ground should be provided with strong cords reaching to the ground that they may be easily opened from below. They should be opened before closing for the last time in order to test the strength of the cord and should not be pasted up or calked. The fireplace flues in the different rooms should be stuffed with paper and the registers closed. Carpets and rugs should be cleared away from the floor as far as possible to prevent their being burned should the acid spatter or boil over.

For generators, stoneware or crockery jars having a capacity of 4 gallons are preferable and may be used with a charge of up to 3 pounds of cyanid. One of these vessels should be placed in each room, with the exception of large rooms requiring a charge of more than 3 pounds of cyanid, when the charge may be divided. One vessel will suffice for each 3,000 or 4,000 cubic feet, preferably the former amount. Under each of these vessels a larger vessel or a rather thick carpeting of old newspapers should be placed, and care must be exercised to see that none of the vessels is cracked, on account of the danger of breakage from the heat generated by the process. Deep vessels are more satisfactory for the experiment than the washbasins often used, but the latter are always available and will serve the purpose. Deeper vessels give greater depth to the

water and acid and accelerate the chemical action, and there is less danger of spattering. Whenever the room is of such size that much more than 3 pounds of cyanid must be employed for it, it is perhaps better to make two charges of half size for such room.

PROCESS OF FUMIGATION.

In the process of generating the gas the water may be measured in a glass beaker indicating ounces, or, for convenience, in a pint cup, and poured into the generators. The acid, measured in the same receptacle, is then slowly and gently poured into the water to avoid splashing or boiling. For all ordinary purposes $1\frac{1}{2}$ pints of the acid and 3 pints of water are sufficient for each pound of sodium cyanid. *The acid should never be placed in the generators first, as advised by some writers, since experience shows that this is dangerous, spattering being almost certain to follow.* When the acid is poured into the water in the jar an ebullition of vapor sometimes arises. Considerable heat is also developed by the addition of the acid.

When the cyanid, which previously should be broken into pieces the size of an egg, is finally dropped into the combined acid and water mixture bubbling takes place similar to that produced by a red-hot iron dipped into cold water. The generation of hydrocyanic-acid gas, the most poisonous gas in common use, begins at once. The gas is colorless and has an odor which has been likened to that of peach kernels. This odor is decidedly metallic, like that produced by striking two pieces of metal together, or of metal against stone. If the fumes are inhaled in any considerable quantity they are almost certain to prove fatal; hence the necessity of extreme care and the advisability of the presence of two intelligent operators in this work. It is even advisable, especially when the first fumigation is undertaken, that one who has had experience with this method of fumigation be present to give directions.

The measuring and preparation of the water and acid in the fumigating jars should be undertaken in a room with a tile or concrete floor if possible, as the strong acid used is apt to injure wooden floors or carpets should spilling occur. The jars may then be distributed to the different rooms and a bag containing the requisite cyanid placed by the side of each.

The house is now in readiness to be fumigated. Coats and hats and everything needed outside must be removed, and preferably two persons should then go to the top of the house, taking different rooms on the same floor to expedite the process, and place the bags containing the cyanid gently into the vessels to receive them. The chemical action will begin at once, but the gas will not rise to any extent for a few seconds or a quarter of a minute, and there is ample time to leave the room quickly without danger of breathing the gas. Having

finished the garret or top floor, the operators should pass rapidly to the next, and so on to the basement, making their exit through the lower door to the street.

Hydrocyanic-acid gas is lighter than air, and consequently rises; therefore the operation must be begun at the top of the house.

The house should be locked from the outside and, if necessary, a warning sign put up to caution against entrance.

The preparation of the different rooms, getting their cubic contents, placing the vessels, and preparing the charges, in a house of the size indicated in the foregoing table, will take from two to three hours, and this much time must be allowed for. The house should remain closed, for the gas to become fully generated and do its work, for from 4 to 6 hours at least—preferably, however, and to get the greatest efficiency, for 24 hours.

Better results are claimed for a warm temperature, say, 70° F. or above, than in a temperature as low as 50° F. or below. Under 50° most insects become torpid, and the effective action of the chemical will be diminished, especially in very low temperatures.

At the close of the operation the doors may be opened and the windows lowered or opened from the outside, and after an hour's airing the house may be entered, if no strong odor of gas is detected, and opened up even more thoroughly, if possible, to allow a complete airing for several hours. The house should not be reinhabited until all traces of the odor of the gas have disappeared. This odor, as stated before, has been compared to that of peach kernels.

The contents of the generating jars should be poured into the sewer trap, or disposed of in some place where they will not be a source of danger, and the jars thoroughly cleaned.

THE CYANID AND GAS A DEADLY POISON.

In the use of hydrocyanic-acid gas for household fumigation we must not for a single instant lose sight of the fact that we are dealing with one of the most poisonous substances known; that the accidental eating of a small portion of cyanid will necessarily be fatal; and that the inhalation of a few breaths of the gas will asphyxiate, and, if rescue be not prompt, have a fatal termination. It is much better, therefore, if fumigation be contemplated, to put the work in the hands of some one who has had experience, if such a person be available; if not, to consider carefully all the recommendations and precautions in this bulletin and become thoroughly familiarized with them before undertaking the experiment.

While the writers thus strongly emphasize the dangerous and even fatal qualities of this gas when breathed by human beings, it is worthy of remark that in the thousands of operations which have been carried on with this gas in different parts of the world only

three cases of fatal accidents to human beings have been recorded. These were due to extreme carelessness in its use. In one case the operator went back into the house after having dropped the bags and closed the building for some time. The abundant experience which has been gained by the different members of the force of the Bureau of Entomology and many others in the fumigation of dwelling houses has demonstrated that all danger is easily overcome by care in conducting the operation. In all the house-fumigation work which has been done during the last 10 years no accident has occurred, except in one or two instances the burning of rugs in attempting to set off charges in too small vessels and a case of headache where a few whiffs of much diluted gas had been accidentally breathed.

It follows, from what we have just said, that there may be danger from fumigating one house in a row of houses separated only by party walls, the other houses being inhabited. Unnoticed cracks in a wall would admit the poisonous gas to the neighboring house. In such a case a householder must consult his neighbors. In isolated houses, however, with the precautions indicated, the operation will be a safe one. The fact that birds resting on the ridge of houses in which the gas was being liberated have been killed by the ascending fumes indicates also that where the house to be fumigated immediately adjoins a higher structure to which the gas may possibly gain entrance there may be some danger to the occupants of the higher structure.

*Single apartments or rooms in buildings should not be fumigated except when the whole building can be vacated during the operation. In case of contiguous houses of loose construction an arrangement should be made so that the adjoining houses also may be vacated during fumigation.*¹

In handling the acid great care should be used in pouring it from the bottle and in putting it into the vessels to avoid spattering on the hands or face, since it will burn rapidly through the skin, and should it spatter into the eyes would cause serious inflammation or loss of sight, or if on the clothing it would burn a hole in the garment. Should a drop fly to the hands or face, bathe the part promptly and freely in water, and the same also for garments or the carpet. It is further desirable to have at hand a bottle of ammonia to neutralize the acid should it spatter on clothing.

The handling of the dry cyanid is not accompanied by any danger if there be no open wound on the hand, but it is advisable to wear an old pair of gloves in breaking up the cyanid and putting it into the

¹ One of the fatalities mentioned in a preceding paragraph resulted from the fumigation of a basement in an apartment house not only without seeing that these apartments and the entire building were vacated and closed during the operation, but without even warning the occupants in the apartments above.

sacks, these gloves to be afterwards burned. The fact that the cyanid has a superficial resemblance to sugar adds to the danger of keeping it about the premises, and it is much better at once to bury deeply or throw down the sewer trap any left-over cyanid.

SUMMARY OF METHOD.

The general directions for treatment may be briefly summarized as follows:

(1) Prepare tabular statement designating room capacity and amount of chemicals for each compartment and secure the chemicals and vessels for generating the gas.

(2) Arrange for the opening of doors and windows from the outside at the conclusion of the fumigation and close all registers, fireplaces, and other openings. Do necessary calking and remove carpets and rugs and moist food material and any metallic objects which are likely to be tarnished.

(3) Place the generating vessels in each room with a thick carpeting of old newspapers under each.

(4) Break up the cyanid out of doors and place it in thin paper sacks containing charges suited to the amounts to be used in the different rooms.

(5) Measure into each of the generating jars the proper amount of water and afterwards add the acid slowly in the proper amount to each of the jars.

(6) Take the cyanid in bags in a basket and place the bags containing the proper amount alongside of the generating jars in each room.

(7) Start at the top of the house and place the cyanid gently, so as not to spatter, into each jar and quickly leave the room. As soon as the upper floor is finished go to the next lower, and pass in this manner from floor to floor until the basement is reached and exit is made through the lower door. If two persons work together in this operation they should both be on the same floor together, taking different rooms.

(8) The following day, or after the completion of the fumigation, open the windows and doors from the outside and let the house ventilate for an hour before entering it.

(9) After the house is thoroughly ventilated and the odor of the gas has disappeared, empty the jars in a safe place, preferably through the sewer trap, and wash them thoroughly and repeatedly before using them for any household purpose.

DATE DUE

Oct 18 '33

AUG 10 '34

Re 3/21/45

Apr 5 '45

Apr 19 '45

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v. 3

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Farmer's bullet

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